HORTICULTURE IN THE BRITISH COMMONWEALTH

AN OUTLINE 1958

by

D. AKENHEAD

Technical Communication No. 26
Commonwealth Bureau of Horticulture and Plantation Crops
East Malling, Maidstone, Kent

COMMONWEALTH AGRICULTURAL BUREAUX

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D. AKENHEAD, O.B.E., M.A., B.Sc.

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INTRODUCTION

THE aim of this compilation is to collect under one cover information which is otherwise only available in very numerous annual reports, journal articles and memoranda.

This information concerns not so much outstanding events as humdrum everyday performance.

The bureau is often asked where work is being done on particular problems and what work is in progress in particular countries and at what research or experimental centres.

Here is an attempt to give a rather general answer to such questions.

It is based mainly on information given for the purpose by the Official Correspondents of the bureau in different countries.

Being the first attempt of its kind by the Bureau of Horticulture it is likely to be notable for errors of commission and omission, but these, it is thought, could be remedied, were future editions thought desirable.

Perhaps the gravest objection of all to the present work is that it concerns only the countries of the British Commonwealth and the Republic of Ireland and the Republic of the Sudan, which are associated with the Commonwealth Agricultural Bureaux. But at least these countries form a convenient and not insignificant starting point in the search for information.

A second stricture may be passed on the unevenness of the information given. That is due, partly, to the widely differing calibre of horticultural endeavour in the countries concerned, but partly also to the fact that the compiler has not attempted to iron out the variously shaped reports received into exactly comparable paragraphs, country by country. The reports varied in length from a few lines to 72 pages of foolscap and in consistency from short concentrates regarding particular countries to half a dozen or more separate accounts of work in different parts of one particular country. The value of trying to mould these into uniformity seemed dubious and life is short. Here are rough notes, not polished periods.

He fully realizes, moreover, the impossibility of listing, to the satisfaction of everyone, the very numerous establishments devoted to the advancement of horticulture. He has not attempted to differentiate between "station" and "institute", "research", "experiment" or "experimental", but has presented them large or small, highly scientific or less scientific as they have been designated by his Official Correspondents or cited in published reports. He has not in general listed those research stations, which are indeed of no little

importance to horticulture, but are run by the several large industrial chemical corporations.

Those who have read so far may have concluded that the present work is not without flaws. If, nevertheless, despite certain blemishes and inadequacies, it is found to possess a modicum of usefulness, a future issue some 3 or 5 years hence could, with the help of criticism from present readers, be a much sounder affair.

Meantime the compiler offers his warmest thanks to his Official Correspondents who almost to a man responded generously, enthusiastically and, in most cases, promptly to his request for information. He hopes that he has not too disastrously garbled their replies. In one or two cases where circumstances have prevented the receipt of information from Official Correspondents he has used instead available published literature. Having no Official Correspondent in the United Kingdom he has received much help from senior horticultural scientists and advisory officers, to whom he is very grateful.

Finally two notes on the text that follows:

1. The information regarding each country is normally given in two parts. The first concerns the actual work in progress or achieved, the second records the research or experimental establishments in the country.

2. Paragraph numbers have one purpose only, namely to facilitate quick use of the index.

D.A.

INDIVIDUAL COUNTRIES

1. ANTIGUA.

The chief crops are Sea Island cotton and sugar cane.

Sugar cane. Varieties grown are confined to those bred in Barbados which are tested in Antigua before being widely planted. The main variety grown at present, B 4098, is likely to be replaced in part by B 49119. The standard of cultivation both estate and peasant has been greatly improved by the adoption of mechanical cultivation, manuring and the introduction and use of herbicides.

Other crops. Trials of castor imported from U.S.A. are not very promising to date. Efforts are being made to increase cultivation of arrowroot and pineapples.

2. AUSTRALIA.

General. Progress is reported from nearly all States of work on the following innovations or new problems: (1) The use of hormone sprays for cultural purposes, e.g. to thin fruits, to prevent fruit drop, in lieu of cincturing in vines, to influence time of harvesting pineapples, (2) Bulk handling fruit and prestorage technique, (3) The newly realized virus problems as they affect horticultural crops, (4) *ditto* nematode problems, (5) New high and low volume spray apparatus, (6) New spray materials, especially organic phosphates. Progress in other directions is indicated below.

3. *Fruit crops, deciduous. New South Wales:* Almond selection; breeding apples and cherries; propagation and rootstocks of pome and stone fruits; delayed foliation in apples and apricots; peach selection to extend canning period; strawberry selection and weed control. *Queensland* [see also Para. **9**]: apple rootstocks; vine rootstocks and zinc deficiency; strawberry selection, planting and mulching. *South Australia:* apple biennial bearing, codling moth and scab; orchard soil management; stone fruit sprinkler irrigation. *Tasmania* [see above *General* points **1-4** and Para. **9**]. *Victoria:* Nutritional problems; soil management viz. mulching or permanent sod, weed control; pest control; stone fruit pruning; small fruit ripening under controlled conditions; vine irrigation and anthracnose control by ziram. *Western Australia:* pear scab; soil management; vine anthracnose control by ziram and thiram.

4. *Fruit crops, tropical and sub-tropical. New South Wales:* Banana beetle borer, leaf spot, plantation layout; citrus fungus and virus diseases, rootstocks; olive varietal, cultural and yield studies; passion fruit pollination and seed germination. *Queensland:* Avocado propagation and nutrition; banana desuckering, leaf spot, propagation and protection from cold; citrus brown spot control with Cu-Zn

sprays, introductions, rootstocks, sod culture; macadamia rootstocks, propagation and processing; papaw selection and irrigation; passion fruit collar rot control by use of *Passiflora flavicarpa* as rootstock and for breeding; pineapple nutrition, ripening with ANA, spacing, black heart, weed and nematode control. *South Australia:* Citrus irrigation and disposal of low grade fruit by juice canning. *Victoria:* Citrus nutrition and soil management.

5. *Vegetables.* In *Queensland* investigations cover the selection and nutrition of beans, crucifers, cucurbits and tomatoes and defoliants to aid in seed production of beans, also trellising of tomatoes, breeding tomatoes for resistance to nematodes and disease, weed control in root crops and harvesting root crops. In *Victoria* attention is being paid to the development of varieties suitable for quick freezing. In *Western Australia* disease and pest control, particularly with zineb, DDT, parathion and malathion is being studied, as also nematode control and virus problems. Packing in plastic containers is gaining ground.

6. *Tobacco.* A Trust Account has recently been established with funds from the Federal Treasury, Growers Associations and Manufacturers. Funds are earmarked partly for research in States concerned, partly for use by C.S.I.R.O. C.S.I.R.O. has set up a Research Institute at Mareeba in Queensland. The Institute, now in its 2nd year, has a staff of 17, including 5 research workers. Problems under immediate survey in Australia concern control of blue mould in growing crops, low average yields and low quality leaf. Breeding is indicated. [See also Para. **16.**]

7. *Sugar cane.* Research on all problems of the cultivation of sugar is undertaken by (1) The Bureau of Sugar Experiment Stations with headquarters at Brisbane and four main Stations at Meringa, Lower Burdekin, Mackay and Bundaberg in Queensland and by the C.S.I.R.O. in conjunction with the Western Australian Department of Agriculture at Kimberley on the Ord River.

8. *Advisory Services.* A Commonwealth Extension Services Grant to each State has given impetus to increasingly effective distribution of information. In practice these grants are restricted to products for which the market potential is such that expansion can be officially sponsored.

9. *C.S.I.R.O. Contribution.* The contribution to horticulture of the Commonwealth Scientific and Industrial Research Organization consists in the organization of both fundamental and immediately practical research on problems affecting the cultivation of horticultural crops. Problems engaging attention at Hobart concern the physiology of apple fruits in relation to storage, gas storage of apples and diphenylamine treatment of apple scald. From Applethorpe in Queensland apple and pear rootstock trials and a trial on the factors affecting storage quality in apples are reported. Oil crops, in particular safflower, castor beans and linseed, are receiving attention in conjunction with various departments of agriculture. Finally, in the

Murray and Murrumbidgee Irrigation areas at Merbein, Victoria, and Griffith, New South Wales, respectively, the specialized technique necessary for the cultivation of crops under irrigation is under continual investigation. Since 1954-55 these two stations have come under one organization. They are now dealing with problems associated with the development of high ground water levels and soil salinity under irrigation and on factors influencing yield in irrigated crops. These include a study of the physiological processes associated with water stress in plants, factors influencing quality in citrus, dried vine fruits and tomatoes and the occurrence and control of parasitic nematodes in irrigated areas. In particular Merbein has been and is interested in the growth and production of vines and the technique of processing vine fruits. It has also paid attention to soil conditions and soil management. Griffith has been particularly concerned with citrus problems and has been conducting factorial experiments on citrus culture, irrigation and nutrition.

10. Research and Experimental Centres.

C.S.I.R.O.—*see also* Paras. **6** and **9**

Commonwealth Research Station, Merbein, Victoria, in Murray Irrigation Areas.

Commonwealth Research Station, Griffith, New South Wales, in Murrumbidgee Irrigation Areas.

11. NEW SOUTH WALES.

Bathurst Experiment Farm. Mainly apple and pear rootstock and breeding work.

Gosford Citrus Experiment Station. Main centre for grape, citrus, stone and pome fruit propagation work—otherwise mainly Citrus Improvement Committee investigations.

Griffith Viticultural Nursery. Vines and citrus [importance declining].

Lower Murray Research Station, Coomealla. Now being developed, citrus rootstock and variety plantings under way.

New England Experiment Farm. Limited apple rootstock and breeding work. Some nursery work.

Somersby Section of Gosford Citrus Experiment Station [*see above*]. Citrus rootstocks etc. plantings established, but not yet bearing.

Wagga and Hawkesbury Agricultural Colleges. Mainly student instruction.

Yanco Experiment Farm. Citrus, stone fruits for canning, varieties, stocks, irrigation, soil management.

Co-operative work with C.S.I.R.O. Homebush. Cool storage and canning sections. Gosford. Citrus Wastage Research Laboratory.

12. QUEENSLAND.

Maroochy Experiment Station, Nambour. Concerned mainly with plantation crops, particularly pineapples, bananas and papaws. The several projects can be classified as nutritional, physiological, plant improvement and plant protection.

Redlands Experiment Station, Ormiston. Mainly vegetables and small fruits, particularly tomatoes and beans. Work involves soil management studies, plant physiology, plant improvement and plant protection.

Field Stations at:

Stanthorpe. Apples, pears, plums, peaches and grapes, their nutrition, soil management, varietal testing and plant protection.

Maryborough. Sub-tropical tree fruits: citrus, avocado and macadamia, their nutrition, soil management and stock-scion relationships.

Ayr. Plantation fruits: pineapples and bananas, their irrigation and soil management in the Dry Tropics.

Cairns. Tropical fruits and vegetables, crop management and plant improvement in the Wet Tropics.

Bureau of Sugar Experiment Stations

Head Office Experiment Station, Brisbane
Northern S.E.S., Gordonvale, Meringa.
Lower Burdekin S.E.S., Brandon, Ayr.
Central S.E.S., Mackay.
Southern S.E.S., Bundaberg.

13. SOUTH AUSTRALIA.

Berri Experimental Orchard. To meet the needs of the Murray Irrigation Areas—cultivation problems of citrus, apricots, peaches, vines, pears, apples, figs and vegetables. Provides a frost warning service.

Viticultural Research Station, Nuriootpa. To meet needs of non-irrigated grape industry in the Barossa Valley—45 acres under wine grapes. Varieties, spacing and cultivation problems in general, frost damage prevention and frost warning service.

Blackwood Experimental Orchard. For non-irrigated deciduous orchard areas—52 acres under apples, pears, plums, apricots, and peaches. All cultivation problems of apples, variety and stock trials of other fruit species. Is an approved Quarantine Station for the introduction, quarantining and working of new varieties.

14. TASMANIA.

Huon Horticultural Research Station, Grove. Apple and pear problems particularly rootstock and pruning trials. Hops, propagation methods and the establishment of disease free clones.

Summerleas Horticultural Station. Previously concerned with vegetable seed production, herbs and drug plants. Main work recently on selection and production of special lines of canning peas and selecting clonal stocks of virus-free strawberries, raspberries and currants (*Ribes*).

New Town Experimental Station. Mainly deals with glasshouse problems, tomatoes being the most important object of selection, breeding and manurial trials.

15. VICTORIA.

Scoresby Horticultural Research Station, Ferntree Gully. Rootstock

investigations for apples, pears, peaches, apricots, cherries, plums and lemons. Pruning, soil management and fertilizer trials with the same. Cool storage research. Variety, fertilizer and rotation trials on main vegetable species and choice of varieties for quick freezing.

Tatura Horticultural Research Station. Peaches, pears and apricots for canning and pears for export. Irrigation, soil management and fertilizers for same. Peach variety and rootstock trials. New laboratory block to be opened on 30th April, 1958, will facilitate intensified research on soil physics and chemistry, plant physiology, entomology, plant pathology and selection for canning.

Viticultural Research Station, Rutherglen and associated *Viticultural Nursery at Wahgunyah.* Varieties resistant to *Phylloxera*, varieties for wine making, investigations of wines made from these varieties.

Horticultural Research Station, Mildura. Citrus rootstocks, varieties. Vegetable and herbicide trials as opportunity offers.

16. WESTERN AUSTRALIA.

Stoneville Research Station. Temperate fruits except vines. Rootstocks, varieties and cultivation. In course of development.

Swan Research Station. Viticultural research cultivation problems.

Tobacco Research Station, Manjimup. Varieties, fertilizers, drainage, irrigation and uptake of chlorine.

Gascoyne Tropical Research Station, Carnarvon. Tropical fruits and vegetables suitable to Irrigation Area, especially bananas and runner beans.

Kimberley Research Station, Wyndham. Tropical crops such as sugar cane, cotton, rice, oilseeds, tobacco and fodder crops in conjunction with C.S.I.R.O.

17. BAHAMAS.

Salient Feature. A most important development in the last 7 years has been the "scarification" of land occupied by *Pinus caribaea.* This land has a thin, hard limestone crust, which has become a highly fragmented mass of honey-comb. Soil is confined to pockets in the honey-comb. The purpose of scarification is to extend the depth of loose, friable surface "rubble", thus increasing root range and an accelerated weathering of the rock to form soil. Land so prepared allows of normal implemental cultivation which is a rare thing in the Bahamas. This rocky soil is dealt with by a D-8 caterpillar tractor to which is attached a heavy rock plough with an angle blade. The blade shaves the rock into small bits and the rocky land becomes so pulverized as to admit of cultivation by modern agricultural machinery. Such treated land has been successfully planted with bananas, papaya, avocado, citrus, etc. or with vegetables such as tomatoes and cucurbits.

Research and Experimental Centres.

Government Experimental Station, Nassau. Chief function is

propagation of tropical fruit trees and ornamentals for distribution. Other work concerns varietal testing of vegetables, storage of onions and introduction of tropical fruit and ornamental trees.

18. BARBADOS.

Sugar cane. Factors which have favourably influenced yield are: Use of improved varieties raised at the B.W.I. Central Sugar Cane Breeding Station in Barbados, notably B 41211, B 4098, B 45151, B 4744 and B 49119. These now tend to replace B 37161. The introduction of new varieties has been accompanied by greater use of machinery, improved drainage and closer spacing. While other pests have been combated, the control of the root borer is still being sought with soil insecticides. Research on the best use of underground water supplies is in progress.

The chief problem of other crops is marketing.

Research and Experimental Centres.

British West Indies Central Sugar Cane Breeding Station—all aspects of sugar cane breeding, despatch of seedlings to contributing countries. Special investigations at present concern the use of hormones for the production of viable seed in crosses which do not normally produce seed, and the introduction of the marcotting method, used at the Canal Point Station in Florida, into the breeding programme.

19. BERMUDA.

Citrus. Investigations show that for nursery citrus stock the standard "T" budding technique gives the best results. Grafting citrus under glass also shows promise.

Lilies (*Lilium longiflorum*): Against severe chlorosis sequestrene NaFe has proved successful either applied to the soil at 30 lb. p.a. or sprayed at 10 lb. per 100 gal. water. CMU applied as a pre-emergence spray at $2\frac{1}{2}$ lb. per acre before weed growth has appeared and again 2 or 3 months later after cultivation has proved highly successful.

Research and Experimental Centres.

Offices and Laboratory of the Department of Agriculture, Paget.

20. BRITISH GUIANA.

Sugar. Total and per acre production continues to increase, amounting in 1957 at 3·30 tons per acre to 284,973 tons from 86,314 acres. This advance can be attributed to progress in mechanization of cultivation, better drainage, use of weedicides, varietal selection—especially lately for resistance to leaf scald disease—intelligent fertilizer practice and greater attention to the timing of harvesting.

Cocoa. The cocoa industry had collapsed by 1920. From 1950 efforts have been made to rebuild it. The Riverain lands of the main

rivers and the lateritic hills in the north-west district are the most promising for the purpose and nurseries are established to propagate cuttings of imported high-yielding clones. The chief varieties which it is proposed to develop are the Trinidad selections ICS 1, 40, 46, 60, 84 and 95 [especially ICS 95], Grenada selections GS 29 and 36 and the Amazonian type IM C67. Some seeds of the Trinitario-Amazonian hybrids, resistant to witches broom are being imported for testing. Clonal material of the Amazonian parents, SCA 6 and 12, have been obtained for propagation.

Coconuts. Selection of high yielding trees and establishment of nurseries is planned. Position stationary.

Coffee. Of the Liberica type, it is grown mainly on tropical peat soils. Cultivation extends to 5,000 acres. Limited export reported mainly to Scandinavia. Robusta coffee is to be encouraged on the hill lands.

Citrus. For local consumption on an acreage of 3,000, grapefruit and oranges and also about 200 acres of limes for oil. Fertilisers are increasingly used.

Miscellaneous. Mangoes, bananas, guavas, avocadoes, pineapples grown for local consumption only.

21. BRITISH HONDURAS.

Organization. Buildings for Agricultural Departmental Headquarters have been in course of erection since 1949-50 in the Western District. They have included accommodation for the Research Section and a laboratory finally put into use in 1957, all at the Central Experiment Station, which covers 750 acres.

Crops. Trials have concerned beans, pineapple and cotton varieties. Plant propagation trials are carried out at district agricultural stations. Trials of tobacco varieties have been completed in the north. Fairly large expansion has followed a cocoa pilot production scheme initiated in 1955. Plans are under consideration for the establishment of a central sugar cane experimental station.

Research and Experimental Centres.

Central Farm Experimental Station, Cayo District. Mainly field and pasture crops.

Sugar Cane Station, Louisville. A new Station is to be established in the Corozal District for problems of sugar cane.

22. CANADA.

Fruit crops. Strawberry indexing is now being done by the Plant Pathology Laboratory, Science Service, Canada Department of Agriculture, Vancouver B.C., and the Horticulture Division, Experimental Farms Service, Ottawa. Initial multiplication is conducted by branch stations in screen houses and isolated plantings, from which stocks are made available to selected growers.

Increased production costs have led recently to greater interest

and the planting of apple varieties on dwarfing and semi-dwarfing stocks such as EM 9, 7 and 2 in the milder areas of Ontario. Efforts are being made by selection and breeding to produce a series of stocks otherwise similar, but standing up to more rigorous climatic conditions. To overcome loss from winter killing in B.C. Antonovka seedlings are being tried as rootstocks with Canada Baldwin as intermediate.

Scab resistant apple seedlings bearing apples $2\frac{1}{2}$ in. in diameter have been selected and will be used for developing seedlings of superior fruit quality. Problems still needing solution are the production of strawberries resistant to red stele and verticillium wilt in Pacific Coast areas and of hardy apple varieties with long storage potential.

23. *Vegetable production.* (1) Improvement in mechanical harvesters has led to initiation of research into such aspects as rate of seeding, spacing and development of special plant types. It is found that bush snap beans grown for processing should be sown more closely, which makes them grow taller. Similarly sweet corn hybrids and peas for canning and freezing have also been developed with a view to aiding mechanical harvesting. (2) With greater concentration of vegetables in particular areas disease control has become all important. Breeding has shown promising results in achieving resistance to the following diseases: tomato verticillium wilt, leaf mould, and late blight; muskmelon fusarium wilt; snapbean bean mosaic virus; slicing and pickling cucumber mosaic and scab, resistance to these two diseases now being combined in some of the newer varieties. (3) Development of vegetable growing in the Prairie Provinces has been made possible by the breeding of new short-season varieties, better irrigation equipment and the provision of water; tomatoes, sweet corn and cucumbers can now be grown. (4) Among new introductions are: white-seeded beans for the processing trade; long slender carrots; F_1 hybrid onions showing greater uniformity of maturity and type and coming in a wide range of seasons; new early, determinate, uniform colour tomatoes. (5) As regards weeds the use of monuron (CMU) in asparagus has become common. Recommendations are now possible for beans, carrots, parsnips and sweet corn, also for canning peas, but the last at high cost. Work continues on weed control for peas and onions.

24. *Floriculture—glasshouse.* Three most important recent trends are: (1) Growing interest in mass merchandising of plants and flowers, (2) Realization of need for better control of glasshouse climate, (3) Increased popularity of chrysanthemum both as plant and for cut flowers. To facilitate mass marketing, breeding and cultural research are aimed at the production of quality plants and short stemmed flowers. Air conditioning of glasshouses is now recognized as desirable for successful flower production. Initial steps towards its introduction have been taken. Exploitation of the principle of photoperiodism, consumer acceptance and new varieties are the

keys to increased chrysanthemum production and its establishment as the most valuable cut flower in Canada. While snapdragon production has declined in favour of imported gladiolus blooms from Florida and forcing of bulbs is proving uneconomic, increased carnation production is evident.

25. *Floriculture—general.* Expansion of industry and building of homes on larger lots in surburban areas has led to increased interest in home gardening and in the materials involved. Commercial interests have led the way and research workers have been sifting the good from the bad. Other spheres in which the research worker has recently benefited ornamental horticulture include the following: (1 Mist propagation. Here intermittent mist operated on electric time-clocks has proved the best system. Better methods of transferring mist propagated cuttings to nursery beds are being evolved. (2) Plastics are now used for packaging and shipment of nursery stock, for conservation of moisture on propagating benches, for air layering, as substitutes for glass in hot beds and glasshouses. (3) The present trend towards low flat houses calls for a matching trend in trees and shrubs. Appropriate selection and breeding work is being done at some research centres. The present popularity of breeding herbaceous plants and the introduction of seed from rogued seedling blocks as "strains" especially of *Hemerocallis, Lilium* and annuals such as China aster, marigold and zinnia lead to lack of uniformity. The position is being watched. (4) Herbicides. Success has been slight with broadleaved crops, but considerable in the control of lawn weeds. (5) Insecticides and fungicides. Out of the first confusion of new materials there have now emerged combination sprays capable of controlling different types of insect and fungus simultaneously. They are expensive.

26. *Cytogenetics.* The Cytogenetics Section of the Horticulture Division has devoted much time to a study of the use of induced polyploidy in breeding and has produced tetraploids of a wide variety of plants. Tetraploids of apple, *Amelanchier alnifolia* and snapdragon are now available and are being used for breeding. Much interest is centred on the use of hybrid varieties of vegetables and petunias. In some crops, e.g. tomato, onion and cucumber, the use of male steriles as the female plant greatly simplifies hybrid seed production. While radiation has not been much used to induce mutations in horticultural crops in Canada, some success has been achieved in inducing colour mutations in apple scions by extensive X-ray and thermal neutron treatment.

27. *Soil management and fertilizers.* Standard levels established as the result of relationships between foliar analysis and yield and storage quality of fruit are being used to estimate fertilizer needs of apples and other tree fruits. With annual crops such as tomato emphasis has been laid on the relationship of soil test to crop response and to fertilizer need as expressed mathematically by Bray's modification of the Law of Diminishing Returns. Constants

have been established for such crops in a number of areas. Attention is being paid to the possible change of the fertilizer ratio from the oxide to the elemental basis. The use of liquid fertilizers for spraying or injecting is being tested.

28. *Irrigation.* This is being increasingly used for fruit and vegetables in Eastern Canada. Two methods in particular for estimating irrigation requirements are coming to the fore, viz. those of the plaster of Paris moisture block and that in which black porous Bellani atmometer plates are used. This latter tool correlates favourably with soil moisture by instrumental methods and with evapotranspiration using the Penman equation.

29. *Micronutrient elements.* Chelates have been used for combating lime-induced iron chlorosis in fruit trees. Micronutrient, including zinc and molybdenum, deficiencies are being identified in various crops in various parts of the country.

30. *Organic soil use.* Much progress is reported in bringing in to use semi-decomposed, highly acid peat soils for the commercial cultivation of onions and potatoes.

31. *Storage and prestorage handling of horticultural produce.* Considerable development has occurred in controlled atmosphere storage in Ontario, Nova Scotia and Quebec, and bulk handling of apples is being tested in the Okanagan Valley, B.C., in Ontario and in Quebec. The test essentially consists of comparison of the use of the new 25 bushel bulk box in place of the bushel box. Special pallet unloading devices and transportation equipment have been designed. More stores are being located at production centres. The average storage temperature maintained nowadays is 30° to 31° F. rather than 32° to 33° F. There is a tendency to higher ceiling stores. Attention has been drawn to the advantage of precooling peaches. Investigations on hydrocooling of celery and sweet corn have resulted in commercial units for this purpose. Vacuum cooling of lettuce and leafy crops is now advocated and practised. Jacketed storage is found to control moisture loss in frozen products. Packaging has benefited greatly from the use of polythene and improved technique. Polythene is used to produce controlled atmosphere storage conditions.

32. Research and Experimental Centres.

These are mainly found in two groups under the Department of Agriculture, namely, the Experimental Farms Service [EFS] and the Science Service [SS]. Others are under University [U] or Provincial management [P].

OTTAWA.

EFS *Central Experimental Farm.* Fruits, vegetables, ornamentals, plant nutrition, cytogenetics, fruit and vegetable storage and preservation.

SS *SS Laboratories.* Bacteriology Division with section on Food microbiology; Botany and Plant Pathology

Division concerned, *inter alia*, with weeds and diseases; Entomology Division concerned with pests.

33. NEWFOUNDLAND.

EFS *St. John's West.* Fruit and vegetables.

SS *St. John's West.* Vegetable insects.

34. PRINCE EDWARD ISLAND.

EFS *Charlottetown.* Fruit and vegetables.

SS *Charlottetown SS Lab.* Vegetable diseases.

35. NOVA SCOTIA.

EFS *Kentville*—fruits, vegetables and ornamentals, fruit and vegetable storage and preservation; plant nutrition.

SS *Kentville, Plant Path. Lab. and SS Labs., Entomology and Chemistry.* Diseases, pests and processing of fruit.

P *Truro Agric. Coll. Dep. Hort.* Fruit, vegetables and ornamentals.

36. NEW BRUNSWICK.

EFS *Fredericton.* Fruit and vegetables.
McDonald's Corner hort. Substation. Fruit and vegetables.
Tower Hill hort. Substation. Blueberries.

SS *Fredericton* Plant Path. and Ent. Labs. Potato viruses, fruit and vegetable insects.

37. QUEBEC.

EFS *Ste Anne de la Pocatière.* Fruit and vegetables..
L'Assomption. Small fruit and vegetables.
Ste Clothilde hort. Substation. Organic soil cultivation.

SS *Ste Anne de la Pocatière* SS Lab. Vegetable insects.
St. Jean SS Lab. Fruit insects and fruit and vegetable diseases.

U *Macdonald Coll. Dep. Hort.* Fruits, vegetables and ornamentals.
Laval Univ. Quebec, Dep. Sci. Vegetables.

38. ONTARIO.

EFS *Harrow.* Fruit and vegetables.
Delhi. Substation. Tobacco.
Smithfield hort. Substation. Fruit and vegetables.

SS *Belleville,* Ent. Lab. Fruit, vegetable and glasshouse insects.
Vineland, Ent. Lab. Fruit insects.
St. Catherines—Plant Path. Lab. Fruit, vegetable and ornamental diseases.
Simcoe, Ent. Lab. Fruit insects.
London, SS Lab. Fruit diseases.
Chatham, Ent. Lab. Vegetable and tobacco insects.
Harrow, SS Lab. Vegetable and tobacco diseases, nematodes, fruit insects.

P *Vineland Horticultural Experimental Station.* Fruit, vegetables, ornamentals; plant nutrition; fruit and vegetable processing.

U *Guelph Agric. Coll. Dep. Hort.* Fruit, vegetables, ornamentals, fruit and vegetable processing.

39. MANITOBA.

EFS *Morden.* Fruit, vegetables and ornamentals; fruit and vegetable processing.
Brandon. Vegetables.

SS *Brandon* Experimental Farm. Vegetable insects.

U *Winnipeg, Univ. Manitoba Dep. Hort.* Fruit and vegetables.

40. SASKATCHEWAN.

EFS *Indian Head.* Fruit and vegetables.
Melfort. Fruit and vegetables.
Scott. Fruit and vegetables.
Swift Current. Fruit and vegetables.
Indian Head Forest Nursery Stat. Ornamentals.
Sutherland Forest Nursery Stat. Ornamentals.

SS *Saskatoon,* Canada Dep. Agric. Res. Lab. Vegetable insects.

U *Saskatoon, Univ. Saskatchewan Dep. Hort.* Fruit, vegetables, and ornamentals.

41. ALBERTA.

EFS *Lethbridge.* Fruit and vegetables and their processing.
Lacombe. Fruit and vegetables.
Beaverlodge. Fruit and vegetables.
Fort Vermilion. Small fruits and vegetables.

SS *Lethbridge* SS Lab. Vegetable insects.

P *Brooks, Provincial Horticultural Station.* Fruit, vegetables and ornamentals.

U *Edmonton, Univ. Alberta, Dep. Hort.* Fruit, vegetables and ornamentals.

42. B.C.

EFS *Summerland.* Fruit, vegetables and ornamentals; plant nutrition; fruit and vegetable storage and processing.
Agassiz. Fruit and vegetables.
Saanichton. Fruit, vegetables and ornamentals; plant nutrition.
Prince George. Fruit and vegetables.
Smithers. Fruit and vegetables.

SS *Summerland,* Plant Path. Lab. Fruit and vegetable diseases.
Summerland, Ent. Lab. Fruit insects and mites.
Summerland. Fruit and Vegetable Proc. Lab. Fruit products; fruit and vegetable processing.
Kamloops, Ent. Lab. Vegetable seed insects.
Chilliwack, Ent. Lab. Carrot rust fly.

Vancouver, Plant Path. Lab. Small fruit diseases.
Saanichton Plant Path. Lab. Fruit and vegetable diseases; nematodes.
Victoria, Ent. Lab. Fruit insects.

U *Vancouver*. Univ. B.C., Dep. Hort. Fruit, vegetables and ornamentals.

43. YUKON.

EFS *Whitehorse*. Small fruits and vegetables.

44. CEYLON.

Horticulture. Investigations are in progress on the following: *Pineapples*—effect of shade, coir mulching, sawdust mulching, elimination of mealy bug by dipping suckers in Folidol, inducement of flowering and retardation of ripening by application of α naphthalene acetic acid, the use of concentrated H_2SO_4 on the crown at flowering. *Citrus*—effects of rough lemon, sweet orange, Heen Naran and Indian mandarin rootstocks on Bibile sweet orange and of sweet orange, Heen Naran, lime, mandarin and rough lemon rootstocks on grapefruit, Bibile sweet orange, Tahiti seedless lime and mandarin; propagation of lime cuttings. *Papaw*—the papain content of different varieties.

45. *Coconuts.* Long term studies at the Coconut Research Institute have proved the value of selecting coconut seedlings in the nursery. Under conditions of open pollination, however, no correlation has been observed between the yields of mother and daughter palms. An isolated seed garden is being planted up using seedlings derived from controlled crosses between high yielding parents. The hybrid between the tall palm, as female parent, and the dwarf palm, as male parent, is showing much promise. Manurial trials have been in progress for many years and coconut water is being used in the diagnosis of nutrient status. Hydroponic experiments on a scale large enough to accommodate coconut palms are also to be undertaken. It has been proved conclusively that complete manuring is an essential prerequisite of replanting old coconut land. Attacks by *Helminthosporium incurvatum* on young palms have been found to be associated with high nitrogen and low phosphate status. Soil fumigation has been found to stimulate the growth of palms and rhinoceros beetle larvae may now be controlled by the use of Shell soil fumigant or dieldrex in the breeding grounds. Trials are in progress on the control of black beetle and termites.

Technological chemical investigations are in progress, also agronomic studies including animal husbandry in relation to coconut farming.

46. *Rubber.* Breeding and selection have been the basis of the work of the Rubber Research Institute. An organized hand pollination programme started in 1939 continued till 1945.

From selected hand pollinated seedlings test tapping trials have produced 80 selected RRIC clones, the best of which produce over

30 lb. dry rubber per tree per year. Reliable "mixed seed" can now be recommended.

Breeding for resistance to *Oidium heveae* has been in progress since 1950 starting with the crossing of the resistant clone LCB 870 with high yielders. In 1957 25 clones were established, but they are not finally tested for resistance, though there are strong indications that a few will prove resistant.

Further hand pollination work since 1953 aims at better high yielding clones resistant particularly to *O. heveae* and *Phytophthora palmivora* and even to *Dothidella ulei*. Introduction has been made in recent years of several Brazilian clones resistant to *D. ulei* and *Phytophthora*. In December 1957 budwood from another 50 *Dothidella*-resistant clones was introduced from the Plant Introduction Station of U.S.D.A. Coconut Grove, Miami, Fla. Some are high yielders. Further exchange has been arranged with the Instituto Agronomico do Norte (IAN) Belem, Brazil, for 25 *Dothidella*-resistant clones, which are $\frac{7}{8}$ *H. brasiliensis* and $\frac{1}{8}$ *H. benthamiana*.

A station is to be set up for testing the resistance to *D. ulei* of the clones made in the Far East from legitimate seedlings of crosses of *Dothidella*-resistant clones with high yielding Eastern clones, this by agreement with Turrialba.

The highest priority is now given to breeding and a Plant Breeding Section is to be set up. The first plant breeder on this assignment will start work in late 1958.

Methods are in progress to control *P. palmivora* leaf and bark diseases and the worst of the root diseases due to *Fomes lignosus*.

Recommendations can now be made on fertilizer mixtures, soil cover and herbicides for use in the Ceylon rubber areas.

47. *Tea*. The Institute's work is being reorganized. Among subjects now under review are: *Chemistry*—economics of manuring. Biochemistry of growing tea leaf; production of "soluble tea". *Technology*—effects of temperature in the fermenting room. Faced with the necessity for proving clones at an early stage the technologist has established a miniature rolling programme, which will give a known relation to large scale manufacture. *Entomology*—mite control in full awareness of the potential dangerous effects of chemicals. Control of fringed nettle grub and shot hole borer. *Plant Physiology*—environmental factors affecting the propagation of clonal cuttings. Early evaluation of yield potential of new clones. Pruning. *Low Country Development*. Detailed plans for a sub-station merely await the completion of financial arrangements. *St. Coombs Estate*—a marked improvement in the clonal areas is noticeable.

48. Research and Experimental Centres.

Horticultural Research Station, Kundasale.
Citrus Station, Bibile.
Coconut Research Institute, Bandirippuwa Estate, Lunuwilla.
Rubber Research Institute, Dartonfield Estate, Agalawatte.
Tea Research Institute, St. Coomb's, Talawakelle.

49. CYPRUS.

Nursery material. Since 1946 greater funds have become available for Government nurseries which are the chief suppliers of fruit, vine, nut, ornamental and vegetable planting material. The establishment of a Quarantine Station, and inspection and control mean that the material available is healthier. New and better vines have been introduced and the cultivation and export of table grapes, especially the seedless Sultanina, have been developed. Encouragement is given to the propagation and cultivation of the carob and a collection of strains and varieties has been made. The propagation and adequate cross fertilization of pistachio are under investigation.

Citrus. A new citrus experimental grove has been established at the Central Government Farm, Morphou, and fertilization, rootstock and irrigation trials are in progress.

Pest control. Much progress is reported in control of the Mediterranean fruit fly by fumigation with ethylene dibromide, bait and general sprays.

Vegetables. The production for export of cauliflower and leek seed is being stepped up, and carrot and melon seed is now also being exported.

Research and Experimental Centres

Central Farm Morphou—citrus.

Other stations include: (1) in the mountains:

Trikkoukkia Station. Deciduous, top and small fruits.

Saittas Station. Deciduous, top and small fruits.

Galata Station. Deciduous top and small fruits.

(2) in the plains:

Kondea Station. Vegetables and olive cultivation and vine and and almond collections.

Xylotimbu Station. Collections of carob and pistacia varieties.

50. FIJI.

Sugar cane. In agricultural exports sugar takes pride of place, being followed by coconut and its products and then by bananas. Work on sugar is controlled by the Colonial Sugar Refining Company.

Coconut. The Coconut Pests and Diseases Board continues its work with particular emphasis on the control of the rhinoceros beetle *Oryctes rhinoceros*. Its main object, namely to prevent the establishment of this pest in the main producing isles of Fiji, has been successful. Its methods are chemical, manual and biological. The establishment of a cocoa research station at which the demands of coconuts may also be studied appears to be imminent.

Bananas. Cultivation and fertilizer trials are reported on bananas, mainly the variety Veimama, as also trials for the control of leaf spot disease and scab moth, spacing, time of planting and purity of strain.

Cocoa. Cautious progress is reported on the planting and development of cocoa and coffee.

Tobacco. There are trial plantings of cigarette tobacco.

Research and Experimental Centres

Principal Agricultural Station, Koronivia. Special attention to rice and bananas.

Plant Introduction and Quarantine Station. Naduruloulou. A project conducted in association witn the South Pacific Commission provides for the introduction of plants and for propagation and supply of seeds or plant material to the South Pacific generally.

Cocoa Station. A site has been selected near Nasavusavu, but a final decision has not yet been reached.

51. GHANA.*

Cocoa. The major research centre is the West African Cocoa Research Institute at Tafo. The territorial department also has its own Cocoa research programme, undertaken largely in liaison with W.A.C.R.I. At Tafo the Plant Pathology division is concerned mainly with swollen-shoot and black-pod diseases. In the former the classification of strains, the transmission and host range of the virus are the chief subjects of study and, in the latter, copper fungicides have been found effective and there is also some evidence of resistant cocoa strains. The Entomology division has been largely concerned with capsid control, endrin being found very useful, and with mealy bug control by the reduction of the attendant ant population. Breeding and selection of cocoas are in progress, with particular interest in the upper-Amazon strains, and vegetative propagation is also an important feature of the programme. The Chemistry division has undertaken fertilizer investigations and fermentation studies.

The Department of Agriculture has also a programme of cocoa research including the field control of swollen-shoot disease, largely by cutting-out following surveys, and of control of capsids, farmers being encouraged to adopt spraying practices. A chain of cocoa stations has been established.

Other crops. The Department is also concerned with the diversification of export crops. Propagation work, agronomic investigations, disease and pest control studies are in progress with coconuts, coffee and oil palms. Citrus, in which the virus disease of limes is a serious problem, is another important subsidiary crop.

52. Research and Experimental Centres.

West African Cocoa Research Institute, Tafo. All aspects of basic research on cocoa problems.

Department of Agriculture. Some 36 agricultural stations are already established or are in process of establishment. These include 17 Cocoa Stations and 14 District Stations. Larger stations concerned with horticultural crops are at:

Kwadaso (Kumasi): forest zone crops.
Bunsu, E. Region, forest perennial crops.
Aiyinasi, W. Region, oil palms.

* Compiled from literature available.

Asuansi, W. Region, citrus, coconuts.
Princes, W. Region, coconut research.
Kpeve, Trans-Volta/Togoland Region, perennial crops.

53. HONG KONG.

Vegetables. Work concerns selection, manuring and disease and pest control.

Fruit crops. Agricultural policy aims at the planting of fruit as an additional source of farm income. A scheme in operation since 1955 encourages the establishment of village orchards and has already resulted in a great increase in acreage under fruit. In the process 300,000 pineapple suckers of Smooth Cayenne and Sarawak have been established. Study indicates that pomelos, lemons, Japanese apricots, litchis, longan and wong pei are suitable.

General. A small research service is being established to deal with (*a*) agronomy, (*b*) crop variety trials and rice breeding, (*c*) entomology.

The entomological service has been set up, a small chemical laboratory is in being and a soil survey is being undertaken.

A Senior Agricultural Officer with research experience is to be appointed in 1959.

54. INDIA.

Fruit crops. In 1948 two schemes were initiated by the Indian Council of Agricultural Research for implementation at its headquarters at New Delhi, one for the monthly issue of a bulletin entitled "The Indian Horticultural Abstracts" and the other for the preparation of monographs describing the most important fruit species cultivated in India. The first of these monographs. The Mango, has recently been published [see review *Hort. Abstr.* Vol. 28, Abst. 2004] and a second on Citrus is in preparation.

Fruit research has now been organized on a regional basis and the programme of research in each region will be co-ordinated by a committee of experts in the region. Each state will in future concentrate on research into and production of those fruit species for which its conditions are suited. Five State Fruit Research Stations have been selected for intensification of research in particular regions as follows: Mashobra in Himachal Pradesh, Saharanpur in Uttar Pradesh, Poona in Bombay, Kodur in Andra Pradesh and Sabour in Bihar. Each will have a number of sub-stations.

In addition to these regional arrangements the Council has sanctioned co-ordinated schemes of an *ad hoc* nature which concern (1) micronutrient deficiencies in citrus, (2) application of growth substances; (3) establishment of Plant Introduction Stations; (4) improvement of date palm cultivation methods; (5) improvement of banana cultivation methods.

55. *Vegetables*. A Central Vegetable Breeding Station has been set

up in the Kulu Valley, Punjab, for work on seed production and improvement by breeding. As a result seed imported before the war is now being produced in India. Eleven Seed Certification Stations are to be established to ensure a supply of pure, genuine weed-free seed. Vegetable seed will have priority.

56. *Floriculture.* The Council has recently set up a Floriculture Committee for improvement and development of ornamental plants. It is proposed that the work on particular plants shall be done in the region best suited to their cultivation, e.g. on orchids at Darjeeling in West Bengal, crotons and other foliage plants at Bangalore in Mysore, jasmines at Coimbatore in Madras and roses at Delhi.

57. *Spices.* The Government of India has set up a Cashew and Spices Development Committee for the promotion of spice production. Research and development schemes have already been taken up in the States concerned.

58. *Horticulture in general.* Research of a fundamental nature will be undertaken by the new Division of Horticultural Research at The Indian Agricultural Research Institute, New Delhi. This Division will also give postgraduate training in horticulture. It is proposed to establish a gamma field at the Institute, where Cobalt 60 will be used to irradiate plant materials for the production of new and useful varieties.

59. *Coffee.* Earlier work on pure line selection has resulted in the isolation of six desirable selections, two of which are under large-scale distribution. Work is in progress to produce varieties resistant to leaf disease. Conversion of poor quality *robusta* to *arabica* tops is proving successful. Manurial trials show the necessity for P and N fertilizers. Foliar feeding trials and trials with chelates are in progress. A quick method of processing cherry into parchment has been evolved. Studies are aiming at the elimination of fruity flavour. BHC 1 per cent wettable powder is proving the best control for the stem borer (*Xylotrechus quadripes*). Bionomics and other particulars are being worked out of the most important parasites of the green-bug (*Lecanium viride*). Low volume sprays are found to compare unfavourably with standard high volume, high pressure sprays.

60. *Rubber.* The rubber acreage has increased from 170,500 in 1950 to 234,400 in 1956 with a slight increase in total yield. A so-called "Rubber Act" has been passed whereby a Rubber Board has been set up aiming at higher yield and lower cost. The two major projects being implemented by it are (1) the Replanting Scheme which provides for the grant of a subsidy for replanting 70,000 acres of low yielding with high yielding rubber in the next 10 years and (2) the Research Scheme which provides for the establishment of a Rubber Research Institute and an Experiment Station. The latter scheme has been in operation since 1955.

61. *Tea.* No significant developments are reported. The area is about stationary, but production has risen in recent years by about 10 per cent.

62. Research and Experimental Centres.

The information given below is based mainly on that given in the Directory of the Agricultural and Animal Husbandry Research Stations in India issued by the Indian Council of Agricultural Research, New Delhi 1955, Rs 1/6. *See also* Paras. **54** and **55.**

ASSAM.

Jorhat, agric. Res. Lab. Chillies, peas, varietal, cultural and manurial trials.

Toklai, Toklai exp. Stat. Tea, general.

63. BIHAR.

Bihar, hort. Res. Stat. Sabour. Tropical and sub-tropical fruits, miscellaneous horticulture.

Patida, exp. Farm. Vegetable variety and manurial trials.

Pusa, Central Sugar Cane Res. Stat. General.

Pusa, Hookah and Chewing Tobacco Res. Stat. General.

Pusa, Indian agric. Res. Inst. (Bot. Substat.). Tobacco and oil seeds.

64. BOMBAY.

Anand, agric. Inst. Tobacco (bidi), breeding and cultivation.

Anand, Tobacco Res. Stat. Breeding and general.

Baroda, agric. Res. Stat. Tobacco and castor, general.

Gandevi, Fruit exp. Stat. Tropical and sub-tropical fruits, general.

Khopoli, agric. Res. Stat. Vegetables, general.

Kirkee, Poona, Ganeshkind Fruit exp. Stat. Fruits, including vines, vegetables.

Mohol, agric. Res. Stat. Oil seed breeding.

Nipani, Tobacco Res. Stat. Tobacco and vegetables, breeding and general.

Niphad, agric. Res. Stat. Oil seeds and vegetables, breeding and general.

Poona, agric. Coll. Farm. Oil seeds and vegetables, breeding and general.

65. COORG.

Oddermotte, Orange Res. Stat. Rootstocks and cultivation.

DELHI.

New Delhi. Indian agric. Res. Inst. Sugar cane and vegetables, breeding and general.

HIMACHAL PRADESH.

Mashobra, Fruit Stat. General.

66. HYDERABAD.

Aurangabad, Fruit Res. Stat. Citrus fruits and grape vine breeding.

Madira, Tobacco Res. Stat. General.

Sangareddi, exp. Farm and Garden. Fruit, vegetables and oil seeds, general.

67. MADHYA PRADESH.

Khandwa, Govt. Seed and Demonstration Farm. Fruits, general.

Nagpur, agric. Res. Inst. Oil seeds, fibre crops and tobacco, general and diseases.

Pachmarhi, hort. Res. Stat. Fruits, vegetables and economic crops [tung, coffee, derris, etc.], propagation [t(ung)., introduction [f & e], seed production [v].

Silari, Vegetable Seed Farm. Selection and general.

68. MADRAS.

Aduthurai, agric. Res. Stat. Vegetables and fruits, varietal cultivation and manuring.

Aduthurai. Central Banana Res. Stat. Varietal and general.

Ambalavayal, agric. Res. Stat. Spices, coffee, cocoa, bananas, pineapples, citrus, general.

Anakapelle, Sugar Cane Res. Stat. General.

Anantharajapat, Fruit Res. Stat. Mango, citrus and other fruits, general.

Araku Valley, Demonstration—cum—Exploratory agric. Stat. Vegetables, spices, fruit trees and beverage plants, manuring.

Burliar, sub-tropical Fruit and Spice Res. Stat. Cocoa, cloves, nutmegs, etc., general.

Coimbatore, agric. Res. Inst. Castor and other oil seeds, general.

Coimbatore, College orchard. Fruits (tropical), and vegetables, breeding sapotas and bananas, improvement of papaw and vegetables.

Coimbatore, Oilseeds Breeding Stat. Varietal trials, and coconut raising.

Devarshola, Nilgiris, UPASI Tea Exp. Stat. General.

Gudiattam, Sugar Cane Res. Stat. General.

Guntur, Cigarette Tobacco Res. Sub-Stat. Breeding and selection.

Kallar, Tropical Fruit Res. Stat. Cocoa and tropical fruits, general.

Kasaragod, Central Coconut Res. Stat. General.

Kodur, Fruit Res. Stat. Tropical and sub-tropical fruits, selection and cultivation.

Lam, agric. Res. Stat. Coriander breeding, tobacco and chillies, general.

Malabar, agric. Res. Stat. Citrus, cashews, coconuts, mangoes, pineapples, pepper and sapota, general.

Mangalore, Cashew Res. Stat. General.

Nileshwar, agric. Res. Sta. III. Coconut, evolution of new varieties, pests, cultivation.

Nilgiris, Pomological Stat. Deciduous fruits, vegetables, general.

Panniyur, Pepper Res. Stat. Manuring and varieties.

Pattambi, Res.-cum-Multiplication Stat. Pineapple, colocasia, ginger, banana, gingelly, varieties and cultivation.

Pilicode, agric. Res.-Stat. Coconut breeding and cultivation.

Rajahmundry, Central Tobacco Res. Inst. Breeding and curing.

Samalkota, agric. Res. Stat. Bananas, general.

Taliparamba, agric. Res. Stat. Areca nuts, coconuts, sapota, pepper, chillies, pineapple, cashews, mangoes, general and varieties.

Tindivanam, agric. Res. Inst. Gingelly and castor oil seeds, breeding and cultivation.

Vadasandur, Cigar and Cheroot Tobacco Res. Stat. General.

Vittal, Arecanut Res. Stat. Diseases.

69. MYSORE.

Babbur, Govt. exp. Farm. Coconut, castor, breeding and acclimatization.

Balehonnur, Coffee Res. Stat. General.

Chethalli, Coffee Res. Subst. General.

Hospet, Sugar Cane Liaison Farm. General.

Yelavare, Regional Farm. Castor and spices, general.

70. ORISSA.

Bhubaneswar, State agric. Res. Stat. Sugar cane, vegetable and fruit seeds, their multiplication.

Pottangi, Govt. Fruit Farm. Deciduous and tropical fruits, breeding and general.

Udaygiri, Turmeric Res. Stat. Turmeric and vegetables, general.

Attari, Govt. Fruit exp. Stat. Tropical and sub-tropical fruits, grape vines, general.

Ferozepur, Tobacco Res. Stat. General.

Ferozepur Cantt., agric. Res. Stat. Tobacco, general.

Gurdaspur, Govt. Garden. Tropical and temperate fruits, grape vines, general.

Hansi, agric. Stat. Tropical and sub-tropical fruits, general.

Jullundur, Sugar Cane Res. Stat. General.

Katrain, Vegetable Res. Sub-Stat. Breeding and general.

Ludhiana, Vegetable Res. Stat. Breeding and general.

Morinda, Govt. exp. Tea Farm. Tea and tung oil, general.

Nagrota, hort. Res. Stat. Deciduous fruits, general.

Palampur, exp. Fruit Farm. Deciduous fruits, walnuts, chestnuts, and citrus, general.

Simla, Simla Sub-stat. Fruits and vegetables, virus diseases.

71. TRAVANCORE-COCHIN.

Kayamgulam, Central Coconut Res. Stat. Pests and diseases.

Kumarakom, Regional Coconut Res. Stat. Cultivation and manuring.

Neyyattinkara, Regional Coconut Res. Stat. Cultivation and manuring.

Thodupuzha, Regional Coconut Res. Stat. General.

For Rubber Research Institute—*see* Para. **60**.

72. UTTAR PRADISH.

Bhadruk, Central Sugarcane Res. Stat. Cultivation and selection.

Chaubattia, Govt. Hill Fruit Res. Stat. Deciduous fruits, general.

Jeolikote, Govt. Valley Fruit Res. Stat. General.

Kanpur, agric. Coll. Res. Farm. Fruits and vegetables, general.

Lucknow, Central Sugar Cane Stat. Cultivation.

Lucknow, Govt. Vegetable Res. Stat. Evolution of high yielding strains.

Saharanpur, Fruit Res. Stat. Tropical and sub-tropical species grown in U.P., 163 acres at Saharanpur and 47 acres at Dehra Dun.

Shahjahanpur. Main Sugar Cane Res. Stat. General.

73. WEST BENGAL.

Chinsura, Banana Res. Stat. General.

Dinhatta, wrapper Tobacco Res. Stat. General.

Krishnagar, hort. Res. Stat. All fruits and vegetables, general.

74. JAMAICA.

Bananas. Since 1947 Lacatan, highly resistant to Panama disease, has replaced Gros Michel. Low volume mist spraying with petroleum oils has revolutionized control of leaf spot in Lacatan. Application by helicopter has also proved effective. These oils have some phytotoxic effect. Various organizations including the Banana Board, the Banana Industry Insurance Board and the All Island Banana Growers Association continue to service the industry. Investigations are now proceeding on the following problems: (1) Nutrition, (2) Timing of crop, (3) Disease and pest control, (4) Fruit handling and storage.

Cocoa. The introduction of shield budding is of major importance and will greatly help in the proposed 50,000 acres increase in cocoa area over the next 10 years based mainly on ICS clones of Forastero type.

Citrus. Since 1947 the acreage has increased by 14,000. The ravages of the fiddler beetle (*Prepodes vittatus* and *Pachneus litus*) have been checked by applications of appropriate formulations of dieldrex 15 or dieldrin 50 per cent. w.p.

Coconuts. The virus nature of "Unknown Disease" or "Lethal Yellowing" has been established. Replanting with a highly resistant variety, the St. Lucia dwarf, is being undertaken.

Coffee. The establishment of central pulperies and a central grading and finishing works shows progress in processing.

Sugar. Factors making recently for greater efficiency have been: Expansion of the facilities of the Research Department of the Sugar Manufacturers Association Ltd. The Department is in close touch with the Breeding Station at Barbados and with the Ministry of Agriculture Plant Protection Division, Jamaica. The West Indies Sugar Company has centralized a number of estates at their Frome and Monymusk factories.

Miscellaneous. With the aid of "Resinik" plastic tape for the tying in of buds it is now possible to produce mangoes and avocado pears in 4-6, as compared with 18-30, months previously.

75. Research and Experimental Centres.

Within the Ministry, Crops and Soils Section, the following three divisions undertake crop research: *Crop Agronomy*, which is building up a group of crop specialists, *Plant Protection* and *Agricultural Chemistry*.

The Ministry operates the following experimental stations:

Hope at Kingston. Cocoa, mango, avocado, pimento.

Orange River at Richmond St. Mary. Cocoa, banana, coconut.

Caenwood at Hope Bay, Portland. Cocoa, banana.

Grove Place at Milegully, Manchester. Citrus, coffee.

Irwin at Montego Bay, St. James. Coconut, cashew.

Bodles at Old Harbour, St. Catherine. Citrus, mango, avocado.

Banana Breeding at Bodles, Old Harbour, St. Catherine. A station is also being established at *Rhymesbury*, Osborne Store, Clarendon. It will be fully irrigated and will deal with banana, citrus, mango and probably cocoa and coffee.

Other organizations carrying out research are:

Research Department of the Sugar Manufacturers Association (of Jamaica) Ltd., Mandeville, Manchester, in collaboration with the Sugar Estates.

Research Department of the All Island Banana Growers Association Ltd., the Banana Building, 10 South Avenue, Kingston Gardens, Kingston.

76. KENYA.

Coffee. The desirability is now established of applying organic manures by means of grass mulch, thereby improving soil structure, moisture acceptance and retention. Mechanization for the control of weeds during the rainy season has been achieved. Details of successful application of herbicides to control broad leaved weeds have been worked out. *Ad hoc* studies with copper fungicides reveal that their use to control seasonal leaf fall while the tree is maturing its crop is highly successful and conduces to higher yields. Several operative factors have been revealed by workers in Kenya enabling better timing for the control of leaf rust (*Hemileia vastatrix*). The status of the mealy bug (*Planococcus kenyae*) has become a minor one as the result of the discovery that placing a band of dieldrin round the base of the tree prevents access by the mealy bug ant. Dieldrin applied to the first 18 in. of the trunk is found to control the white borer (*Anthores leuconotus*) effectively. This confirms work in Tanganyika.

Antestia (*Antestiopsis* spp.) was found in 1957 to be controllable by malathion sprays. Against leaf miners (*Leucoptera* spp.) malathion sprays give effective control of the moth and diazinon of the larvae in the leaf. Coffee berry disease is under investigation.

77. *Tea.* Since the incorporation of the Tea Research Institute at Kericho in 1951 research findings from other countries have been tested under East African conditions. In the Agricultural Department the main projects have concerned the nutritional requirements of tea and methods of vegetative propagation; other subjects studied include weed control and the effects of different pruning cycles. The work of the chemistry department has been concentrated on soil chemistry and its effect on tea growth, and on the chemistry of tea fermentation.

78. *Pyrethrum.* Investigational work continues on the following among other subjects: Irrigation, windbreaks, manuring, minor element deficiencies. Experimental work in which the application of research to practice is being tested has covered manurial trials, phosphate/ridging trials, stripping trials, rotation and cutting back trials. Selection and breeding continues [taken from report for 1956 of Senior Pyrethrum Officer].

79. *General horticulture.* Horticultural officers in Kenya are concerned more with the application of research findings to Kenya conditions than with basic research itself. Encouragement is given by them by lectures, press articles and personal advice to growers on the cultivation and sometimes processing of crops likely to fit into the economy of the country.

80. Research and Experimental Centres.

East African Agriculture and Forestry Research Organization [E.A.A.F.R.O.], P.O. Kikuyu. This is the headquarters of an inter-territorial research organization which is administered by and is part of the East Africa High Commission. It was set up in 1948 and absorbed the earlier East African Agricultural Research Institute at Amani in Tanganyika. This organization, which serves the three East African territories and Zanzibar, is concerned with basic research of a long-term nature, with problems common to several territories and those which need research of a highly specialized nature. Of horticultural interest in recent years, the organization has been responsible for investigation into sudden death and dieback diseases of cloves and of premature nut-fall and the gumming disease of coconuts.

Scott Agricultural Laboratories, P.O. Box 30032, Nairobi. Specialist divisions of the Department of Agriculture: Entomology, plant pathology, soil chemistry, seed testing.

Coffee Research Station [D. of A.] P.O. Ruiru with sub-stations elsewhere. Mainly *Coffea arabica.*

The Tea Research Institute, P.O. Kericho.

High Level Sisal Research Station [D. of A.], P.O. Thika.

Horticultural and Pyrethrum Research Station [D. of A.], P.O. Box 100, Molo. (1) Headquarters of horticultural section of the Ministry of Agriculture—deciduous and soft fruits and deciduous vegetables. Sub-station for sub-tropical fruits at Kitale, and at Perkerra Irrigation Scheme for sub-tropical fruits and vegetables. (2) Headquarters of Pyrethrum section of Department of Agriculture with sub-station at Ol Joro Orok.

Horticultural Research Station [D. of A.], Thika—pineapples and other sub-tropical fruits and vegetables.

Tree Crops Research Station, P.O. Kikambala. This new coastal station will deal with tropical and sub-tropical fruits, coconuts, cashews, etc. Sub-station at Matuya. Other small sub-stations for date culture.

81. MALAYA, FEDERATION OF.

Cocoa. Local Trinitario and Criollo have been tested and selected. Importations have included Amelonado, Trinitario and Upper Amazon material. Manurial studies are yielding results. Propagation methods have been improved. For the establishment of young plants veneer tubes as containers have been proved best.

Coconuts. N, P and Mg have proved beneficial nutrients. Coffee, tea and pineapples have been grown successfully as undercrops.

Coffee. Liberica is now generally preferred to Robusta. It yields best without shade. Mulching +N found expedient on mineral soils and K and Cu essential on deep peat soils.

Fruit crops. Rambutan clones have been selected. Pruning trials have led to the adoption of an open centre type head for rambutan and a natural head for durian.

Oil palms. Response is given to N, P and Mg manuring. Newly planted palms are deleteriously affected by the non-felling of old ones.

Tea. A new technique has been developed for propagating lowland tea, namely, the use of nodal cuttings rooted in a prepared medium in polythene cloches under shade. N and P, especially in combination, increase the yield of highland tea.

Miscellaneous. Progress has been made in testing imported manila hemp varieties, choice of cover crops and the control of *Imperata cylindrica.*

Rubber. The report of an advisory committee enquiring into the production, development and consumption research in the natural rubber industry was submitted to the Chairman of the Rubber Producers Council in 1957.

82. Research and Experimental Centres.

Federal Experiment Station, Cameron Highlands. Tea, vegetables, coffee, N.Z. flax.

F.E.S. Serdang. Oil palm, cocoa, manila hemp, fruit propagation, vegetables.

F.E.S. Jerangau. Oil palm, cocoa.

F.E.S. Telok Bharu, Perak. Coconut.

F.E.S. Jalan Kebun, Selangor. Pineapple, coffee.

F.E.S. Alor Bukit, Johore. Pineapple.

F.E.S. Degong, Perak. Manila hemp, coconut.

F.E.S. Sungei Ruan, Pahang. Manila hemp.

F.E.S. Kuala Lumpur. Vegetables, tobacco.

F.E.S. Gajah Mati, Kedah. Citrus.

Rubber Research Institute of Malaya, Kuala Lumpur.

83. MAURITIUS.

Citrus. Owing to tristeza citrus has almost disappeared. A future revival based on the use of mandarin rootstocks seems just possible.

Irrigation. Overhead irrigation combined with contour planting

has made greater yield and production over a longer period of time possible for many crops.

Sugar cane. This remains the chief economic crop of the Island. Its control is now out of the hands of the Department of Agriculture.

Tea. Good results have been obtained from the cold storage of tea seed. Seed stored at 40° F. retained viability up to 6 months.

Tobacco. Production of healthy seedlings has been improved by better control of red ants, cutworms, leaf eating insects and leaf miners by aldrin or endrin, by the use of soil blocks for seedlings and the use of ethylene dibromide against nematodes. A local selection of Yellow Mammoth shows resistance to black shank.

Vegetables. Seed production of most temperate and tropical vegetables is now well established.

84. Research and Experimental Centres.

Curepipe Exp. Stat. 80 acres, citrus fruits included.

Central exp. Stat., Reduit. 20 acres, vegetables and citrus included.

Barkly Exp. Stat. Fruit tree propagation, vegetable seed production, ornamental trees and shrubs.

Richelieu Exp. Stat. 100 acres. Included are tobacco, vegetable seed production, fibre crops, integration of sugar cane and arable crops, mechanization, overhead irrigation, fruit trees.

Pamplemousses Exp. Stat. 10 acres tobacco and food crops. Under the Tea Division, Department of Agriculture.

Tea Exp. Stat., Wooton, Curepipe. Cultivation, propagation and seed production.

Also *The Mauritius Sugar Industry Research Institute* at Reduit is now in charge of all research and extension work on sugar, apart from the needs of the small planters who are looked after by the Extension Services of the Department of Agriculture.

The Institute with Field Stations in different climatic zones has Departments of Agronomy, Chemistry, Botany, Plant Breeding and Genetics, Plant Pathology, Entomology and Sugar Technology.

85. NEW ZEALAND.

Fruit crops, Deciduous. Apples. Bulk handling of fruit introduced in 1953 is among the most important of recent innovations. Briefly, the crop is picked into large bins of 35-100 bushel capacity, which are either mounted on trailers or handled by fork-lift for direct delivery to the grader. Pallets and fork-lift have greatly reduced bruising and have speeded transport. EM.XII and XVI rootstocks having been now propagated in quantity are available and recommended for use when replanting instead of Northern Spy. Search is being made for rootstocks resistant to *Phytophthora cactorum*. Mosaic is found to spread by root crossing. Manurial trials started in 1930 show that N is the most important nutritional element, hence a study of N compounds in the aerial parts of the tree is now in progress. N in sap is found to have an organic form and it is hoped that

this study of composition and seasonal changes therein may lead to the development of a quick test for the N status of the tree. *Pears:* Wilt during storage has been greatly reduced by inserting a single sheet of waxed paper inside the corrugated pad in Winter Cole pears. *Apricots:* Determination by the Fruit Research Division, D.S.I.R., of temperatures dangerous to apricots at successive stages of development has enabled 5 successive crops to be saved from frost damage. *Stone fruits in general:* Metal chelates are found incapable of curing nutritional deficiencies and foliar fertilizer applications have proved unsuccessful. Plum mosaic has been eliminated from rooted cherry-plum cuttings used as stocks simply by roguing. *Antibiotics:* Streptomycin has become the standard control of bacterial diseases of apple and stone fruits. *Small fruits:* Two raspberry varieties from the U.S., Taylor and Marcy, show promise for particular conditions. Goliath and Cotswold Cross are pre-eminent among black currants. A successor to the Auchincruive Climax strawberry is being sought in introduced English and U.S. varieties.

86. *Fruit Crops, Subtropical.* Considerable development is noticeable in the areas devoted to the cultivation of the following, especially the first two species: tree tomato (*Cyphomandra betacea*), Chinese gooseberry (*Actinidia chinensis*), passion fruit (*Passiflora edulis*) and feijoa (*Feijoa sellowiana*).

87. *Fruit Crops, Citrus.* Both rootstocks and scions are now carefully examined to eliminate virus before being propagated. *Poncirus trifoliata* has proved successful for orange and mandarin. New successful varieties are Carters Navel orange and Silverhill mandarin. Preharvest drop is now regularly controlled by 2,4-D (20 p.p.m.) spray. The treatment of fruits with 2,4,5-T (200 p.p.m.) reduces stem end rot and increases quality in store. The impregnation of fruit wraps and case liners with diphenyl reduces wastage in transport and storage. Juicing machines have been installed in packing houses.

88. *Vines.* Since 1952 56 wine varieties have been introduced, from France including several hybrids, from U.S.A. and from South Africa. Other introductions are of table grape varieties. Innovations include the displacement of disc and harrow by rotary hoe and the imminent use of automatic retractable cultivators under trellised vines. Rubber bands replace string for tying in.

89. *Vegetables.* Progress is reported in breeding beans for resistance to rust, garden peas to wilt and mosaic, swedes and cabbage to clubroot and mosaic, hops to root rot, tomatoes to leaf mould. Owing to the increase in cauliflower mosaic growers are recommended to isolate seed beds. The area under crops for quick freezing was almost as great in 1957 as that for fresh marketing crops, beans and peas being the most important.

Recently a scheme covering the multiplication of selected citrus and vegetable seeds produced by the Crop Research Division of D.S.I.R. and the Horticultural Division of the Department of

Agriculture has come into operation. The Horticultural Seedsmens' Association undertakes the multiplication and the Horticultural Division the inspection.

90. *Disease Control. Quarantine.* Regulations were revised in 1957. Quarantine and fumigation stations using methyl bromide have been set up. Overseas aeroplanes and their passengers' baggage are most carefully dealt with. *Spray timing:* Observations are determining the flight periods of codling moth and leaf roller. *Spray apparatus:* For high volume (normal dilution) spraying air blast apparatus has been introduced for large orchards. Low volume (semi-concentrate) sprayers are in use in smaller orchards. Helicopter spraying is being tested.

91. *Glasshouses.* Expansion in area is noticeable with emphasis on new types of steel construction. Polythene is replacing glass for covering propagating benches. Mist propagation with electronic control is being adopted both in houses and outdoors. The use of trickle irrigation and liquid feeding of crops has been developed by the Department of Agriculture and Massey College.

92. *Floriculture.* Planned breeding is in progress on lilies, especially *L. parkmanni*, coloured arums (*Zantedeschia rehmanni*) and gerberas.

93. *Hormones for cultural purposes.* Progress is noticeable in weed control in raspberries (D.N.B.P. and D.N.A.P.) and nursery stock (chloro-IPC and Crag herbicide), in chemical thinning (α-NAA) and fruit holding (2, 4-D).

94. *Soil Management.* Sprinkler is replacing furrow irrigation. There is a tendency towards the grassing down of orchards, especially those of pome fruits.

95. *Miscellaneous Groups.* The cultural investigation of hops at Motueka, *Phormium tenax* at Moutoa and tobacco at Motueka is in the hands of the D.S.I.R.

96. Research and Experimental Centres.

Plant Diseases Division, D.S.I.R., Mt. Albert, Auckland. Pests, diseases, microbiology and use of therapeutants, plant pathology, bacteriology, viruses especially of Phormium and of fruit trees. Insecticides and fungicides, timber preservative treatments.

Fruit Research Station, D.S.I.R. Mt. Albert, Auckland. Physiological diseases, plant nutrition of pome and stone, citrus and subtropical fruits, all cultivation problems and storage. Sub-stations at (1) Oratia, South Road, Henderson, Auckland, (2) Havelock North, Goddards Lane, (3) Appleby, P.B. Nelson and (4) Earnscleugh, Alexandra R.D., Central Otago.

Cawthron Institute, Nelson. Plant chemistry and trace element deficiencies; fungus diseases of fruit, hops, tobacco and market garden crops.

Entomology Division of the D.S.I.R. stationed at Cawthron with sub-stations at Ashburton and c/o Grasslands Division, Palmerston North, P.O. Box 623.

Te Kauwhata Horticultural Research Station, Agric. Dep., Hamilton, Viticulture and wine making.

Rukuhia Soil Research Station, Ext. Div., Agric. Dep., Hamilton. Manurial trials, soil analysis.

Forest Research Institute, N.Z. Forest Service, Whaka, Rotorua. Forest problems and their contacts with horticulture.

Massey Agricultural College, Palmerston North. Glasshouse crops and problems including trickle irrigation and mist propagation. Dwarf rootstocks.

Seed Testing Station, Ext. Div., Agric. Dep., Palmerston North. Testing crop seeds including vegetable seeds.

Levin Horticultural Research Station, Department of Agriculture, Kimberley Road, Levin. Berry fruits and vegetables, weed control in vegetables and flowers, varietal and manurial trials on glasshouse crops.

Wallaceville Animal Research Station, Agric. Dep., Upper Hutt. Includes apiculture re pollination and spray residue toxicity.

Soil bureau, D.S.I.R., Molesworth St., Wellington and Experimental Station, Taita, Eastern Hutt Road, Lower Hutt.

Otari Open Air Native Plant Museum, Wilton Road, Wellington. Plants indigenous to N.Z.

Hop Research Station, D.S.I.R., Riwake, Nelson. Diseases, cultural and drying problems.

Tobacco Research Station, D.S.I.R., Motueka, Nelson. All phases of culture and curing. Breeding.

Crop Research Division, D.S.I.R., Lincoln, Canterbury. Improvement of vegetable and other crops, particularly by breeding, especially for yield and disease resistance. Swedes, linen flax, linseed, peas included, substations at Otara and Gore.

Botany Division, D.S.I.R., 2 Latimer Square, Christchurch, C.I., Box 2015. All aspects of plant life. Large herbarium which includes seeds, pollens, etc. Botanical experimental garden under construction.

Canterbury Agricultural Station, Lincoln College. Horticultural research on plant diseases.

Invermay Agricultural Research Station, Department of Agriculture, Mosgiel, Otago. Includes varietal and manurial trials on linseed and peas and club root in turnips and swedes.

97. Other activities of the Department of Agriculture include the following:

Work on small trial areas at Kerikeri on citrus problems and at Avondale on organic wastes, trials and experiments throughout the country on growers' properties and elsewhere on a multiplicity of problems, fumigation experiments at Wellington and cool storage trials.

98. NIGERIA.

Overall picture. Horticultural research and development in Nigeria is in the hands of two major inter-territorial research

organizations, namely, the West African Institute for Oil Palm Research which is situated near Benin, and the West African Cocoa Research Institute Station at Ibadan, and of the various Ministers of Agriculture, both Federal and Regional; there is also a nucleus of privately financed horticultural research.

99. *W.A.I.F.O.R. and Oil palms.* Germination is found to be quicker in oxygen than air; the best temperature is 40° C. No medium is necessary, provided seeds are kept moist. Optimum moisture for *tenera* is 22 per cent water to dry weight and for *dura* 18 per cent. Perenox and organic fungicides have proved efficacious against the freckle and anthracnose organisms now identified. Trials in progress have shown the value of watering, mulching, the application of bunch refuse and of N. Early transplanting and planting with a ball of earth are advisable. Root pruning and dipping in a clay slurry have also proved useful. Orange frond disease is found to be due to Mg deficiency and to be curable by injection, spray methods and soil applications. Whereas development and yield are normally increased in early years by intercropping with food crops, local conditions are found largely to govern how long such a practice is desirable. The influence of climate on sex ratio and hence on yields has been worked out. Detailed consideration has been given to the method of selecting palms for yield, in which both the mesocarp oil content and the kernel content of the fruit are taken into account.

Data of bunch production of groves afford a starting point for new work aimed at improvement of groves. A trial at Abak shows the advantage of clear felling any grove which is to be replanted. Other investigations in the last 5 years on which articles have been published concern: pollination and pollen storage performance of Deli palm in W. Africa; root distribution and anatomy; colour of fruits; vascular wilt disease in relation to K nutrition; the influence of ecological factors on the incidence of oil palm diseases in Nigeria.

100. *Federal Research.* The Federal Department is concerned mainly with fundamental and long-term research and works in co-ordination with the Regions. In recent years attention has been given mainly to pest and disease control in cocoa: there has been progress with the control of black pod disease by encouraging farmers to use fungicidal sprays and with capsid control by using BHC. Cocoa breeding has also received attention together with selection work and agronomic studies of avocado, citrus, coffee, kola, papaw, pineapples and tomatoes.

Citrus. The following rootstocks have been under trial at Ibadan for sweet orange and grapefruit since 1931; mandarin, tangerine, sour orange, acid lime, sweet orange, grapefruit, shaddock and hybrid lemon. No fertilizer has been used and grass has been allowed to replace the original leguminous cover. The budded trees concerned reached their peak of production in the 11th to 15th years, after which, generally speaking, a decline in production has been noticeable. Of the stocks mentioned the best yields of sweet orange (Ruby

Red) have been on mandarin, tangerine and sour orange. In view of the susceptibility of sour orange to tristeza other rootstocks seem desirable and a further trial was established at Ibadan in 1952 in which tangerine, tangelo hybrids and rough lemon were included. In these trials, moreover, fertilizers are being applied. So far promise is shown by Cleopatra tangerine, and Late tangelo. For grapefruit in the 1931 trials the rootstocks inducing the greatest weight of fruit were sour orange followed by mandarin. It is noticeable that in Florida trials economic productivity increases well beyond the 25th year. In Nigeria only the tangerine rootstock showed some tendency to sustain yields in the 21st to 25th years after a drop in the 16th to 20th years. This holds good for both grapefruit and sweet orange tops. Mandarin also helped to sustain yields, but only in sweet orange.

101. *Regional Research.* Each of the three Regions—Northern, Western and Eastern—and the Southern Cameroons under U.K. Trusteeship—has a programme of agronomic studies and variety trials with the main crops of the region. These are: Northern—tobacco, sugar cane, citrus, mango, dates, kola and European vegetables; Western—cocoa, which is largely concerned with swollen-shoot disease control by inspection and cutting-out together with the control of black pod and capsids, rubber, kola, citrus, coffee and oil palm; Eastern—cashew, citrus, cocoa, coffee, oil palm and rubber; S. Cameroons—cocoa, coffee and tea. In the S. Cameroons also the Cameroons Development Corporation at Bota is concerned with agronomic work on bananas, cocoa, oil palm, rubber and tea.

102. *Privately Financed Research.* The United Africa Company maintains an organization for research into oil palm and rubber production on a plantation scale, while the Nigeria Tobacco Company undertakes agronomic research into tobacco production largely by peasant farmers.

103. Research and Experimental Centres.

Publicly Financed Research.

I. Inter-territorial research organizations.
   (*a*) *The West African Institute for Oil Palm Research*, near Benin. All aspects of oil palm research.
   (*b*) *The West African Cocoa Research Institute, Nigerian Substation*, Moor Plantation, Ibadan. All aspects of cocoa cultivation.

II. Federal research.
   (*a*) *Ministry of Research and Information*, via Director of Agricultural Research, Moor Plantation, Ibadan. Varietal and rootstock trials on avocado, citrus, coffee, kola, papaw, pineapple. Breeding kola. Quarantine stations at Moor Plantation, at Calabar, in the Eastern Region and at Kano in the Northern Region where new horticultural material, particularly cocoa and rubber, is introduced and tested.

III. Northern Region Research.
Ministry of Agriculture and Natural Resources, Northern Region via Secretary for Agricultural Research. *Northern Region Research Station*, Samaru, near Zaria. Varietal and rootstock trials of citrus and mango. Cultivation of kola, dates, tobacco and European vegetables.

IV. Western Region Research.
Ministry of Agriculture and Natural Resources via Director of Agriculture, Ibadan. Cultivation of citrus, cocoa, coffee, pineapples, rubber and oil palms.

V. Eastern Region.
Ministry of Agriculture and Natural Resources via Director of Agriculture, Enugu. Cultivation of cashew, citrus, cocoa, coffee, oil palms and rubber and the commercial production of European vegetables.

VI. Southern Cameroons under U.K. Trusteeship.
(*a*) Department of Agriculture via Principal Agricultural Officer, Buea. Cultivation of cocoa, coffee, tea.
(*b*) Cameroon Development Corporation via General Manager, Bota. Banana, cocoa, oil palm, rubber, tea, and Indian pepper.

PRIVATELY FINANCED RESEARCH.

I. Research Department United Africa Co., Pamol Estate, Sapele. Oil palm and rubber at various regional centres.

II. Nigeria Tobacco Co. Ltd., Marina, Lagos. Tobacco production at various centres by peasant farmers.

104. FEDERATION OF RHODESIA AND NYASALAND. NORTHERN RHODESIA.

Background. As yet only a small part of the population is interested in horticultural production.

Potential sources of horticultural information. In 1951 a Horticultural Section was established on the Demonstration Farm at Kambowa near Ndola. In 1956 the farm was taken over by the Federal Department of Conservation and Extension. In December, 1956, the officer i/c of the Horticultural Section became first professional Horticultural Adviser in the field and another horticulturist was appointed Horticultural Farm Manager at Kambowa.

Citrus. The end of the last decade shows some 24,000 citrus trees in bearing and another 23,000 non-bearing trees.

Other fruits. Want of a market rules out as yet the commercial cultivation of other fruit crops.

Miscellaneous. Essential oils can be grown, but interest is dormant. A Hydroponics Society has been formed in the Copper Belt.

105. RESEARCH AND EXPERIMENTAL CENTRES.

Kambowa Demonstration Farm, Ndola. Run as economic unit, includes certain horticultural crops.

Msekera Demonstration Farm, Fort Jameson and *Mochipapa Demonstration Farm,* Choma. Both deal with tobacco.

A Tobacco Experimental Station is to be opened by the Tobacco Research Board at Broken Hill in the very near future.

106. SOUTHERN RHODESIA.

Tobacco. In 1950 tobacco research in Southern Rhodesia became the responsibility of the Tobacco Research Board of Southern Rhodesia, later, in 1955, of Rhodesia and Nyasaland. Considerable changes have been made in recent years in the organization of the industry. A succinct account entitled "Tobacco Farming in Rhodesia and Nyasaland 1889-1956", by F. A. Stinson issued by the Board deals with them and with research progress.

Fruits. Mineral deficiencies Zn, Mn and Mg, not climate, are now found to be the cause of unthriftiness. White Winter Pearmain and Macintosh Red apple varieties are good indicators of Mg deficiencies. Tip-bearing and other apple varieties do well and can be grown economically at 5,500-6,000 ft. Varietal and pruning recommendations can be made for peaches at that altitude. It is found that Fuerte avocadoes can be allowed to hang on the tree for 3-4 months. To achieve a low branched, longer bearing papaw scraping out the growing point after the first crop is recommended.

Vegetables. A routine sodium or ammonium molybdate liquid application is now used for each cauliflower crop. Boron deficiency occurs in known diminishing severity in different crops. In periods of high humidity zineb and/or captan + added spreader controls leaf spot diseases. English are ousting American tomato varieties as having better quality fruit more resistant to cold and disease.

Mineral Deficiencies. African marigolds and *Salvia splendens* are found to be rapid indicators of Zn deficiency in the red soils.

107. Research and Experimental Centres.

Kutsaga Tobacco Research Station.

Trelawney Tobacco Research Station.

Rhodes Inyanga Orchards Experiment Station, P.B. 44, Rusape, Deciduous fruits.

Henderson Research Station, P.B. 4, Mazoe. Includes experiments on onions and on onion, pea and lettuce seed production.

Sabi Valley Experiment Station, P.B. 395c Umtali. Irrigation low veld station—includes bananas and dates.

Panmure Hybrid Maize Farm, P.O. Shamva. Includes experiments on Burley and Fire-cured tobacco.

Departmental Officers carry out small plot horticultural experiments on growers' farms.

108. NYASALAND.

Coffee. Once an important crop, production stopped at the beginning of the century. It is now being revived and work is in progress

at two stations on it. Results of work to date stress the necessity for mulching and the dangers of planting temporary shade trees.

Tea. A Tea Research station was opened in 1949. Output has risen by $3\frac{1}{2}$ m. lb. to 20 m. lb. in the last 10 years due to increased acreage, replacement of low yielding types and better field management. Information is now available on successful establishment of newly planted tea, response to fertilizer and best time of application, value of shade for increasing stand per acre and extension of pruning cycles. Mist-propagation has proved successful and a Seed Certification Scheme encourages production of good seed.

Tung. While specific research has lessened, production based on previous research has increased from 170 long tons oil in 1947 to 867 l.t.o. in 1956. Acreage curve moved from 12,650 to a maximum of 21,400 in 1952 and then dropped to 18,800 at present. A range of higher yielding clones of *Aleurites montana* has been established. Mother plants are available for future breeding, if occasion demands. N fertilizers are the only ones which have consistently resulted in increased yield. Clean cultivation, especially in the early stages, helps yield. The water needs of the crop are being investigated in a study of biennial bearing. Crosses have been made with *A. fordii*.

109. Research and Experimental Centres.

Agricultural Research Station, Chitedge, P.O. Box 158, Lilongwe. Tobacco.

Bvumbwe Experimental Station, Box 48, Limbe. Tung, coffee, deciduous fruits.

Makanga Experimental Station, P.O. Chiromo. Cocoa, sugarcane.

Tea Research Station, Box 49, Mlanje. Tea, cocoa, weed control.

110. PAKISTAN.*

N.W. FRONTIER PROVINCE. Horticultural research is carried out at the *Agricultural Research Station, Tarnah Farm.* It covers (1) Introduction and selection of fruit and vegetable varieties,' (2) Cultural practice regarding rootstocks, manuring and pruning of peaches.

111. PUNJAB. The chief educational centre is the *Agricultural College, Lyallpur,* with the Fruit Specialist, Punjab, in charge. A degree in horticulture is obtainable. Research is in progress at: (1) *Lyallpur Fruit Section*—varietal and cultural experiments on tropical and sub-tropical fruits. (2) the *Horticultural Research Sub-station, Montgomery*—for citrus rootstocks, vine breeding and (3) the *Horticultural Research Sub-station, Sunny Bank* (Murree Hills)—cultural investigations on deciduous fruits. Much attention is devoted to the provision of pedigree fruit trees and the Government has a network of nurseries all over the Province. the largest being at Lyallpur, with smaller ones at Jhang, Montgomery, M tan Gujranwala and Sargodha and in the Murree Hills. There is a 28 acre Date Farm at Jhang with a plantation of Arabian varieties for the pro-

* From notes received in 1955.

vision of suckers. Thanks to the efforts of the fruit specialist and his staff and the advisory work undertaken by them commercial fruit growing has increased greatly in the last two decades. A notable advance has been the establishment of the Punjab Co-operative Fruit Development Board. This Board keeps the needs and aims of the fruitgrower in the Government eye. Its Honorary Secretary is the fruit specialist. It publishes the *Punjab Fruit Journal*. It conducts courses and demonstrations.

112. SIND. The establishment now consists of 1 full-time Government Horticulturist, 9 Horticultural Supervisors and 5 Research Assistants. Their functions would appear to be mainly observational and advisory.

113. BALUCHISTAN. A small advisory service for practical use.

KARACHI. Two officers supervise the set up of horticulture, viz. (1) Assistant Engineer, Independent Horticulture Sub-Division, Pakistan Public Works Department, and (2) Superintendent Horticulture, Karachi Administration. The first deals with government gardens, the second has a nursery at Lalukhet for supplying ornamental plants for public places, avenues, etc.

114. EAST BENGAL. Under the six year plan of the Government of Pakistan a scheme was adopted in 1951 called "Agricultural Organization of Horticultural Section for Developing Fruit and Fruit Products Industry in East Bengal". Finances are provided half by the Central Government and half by the East Bengal Government. Four gardens are being set up, namely, at Dacca, Chittagong, Khulna and Rajshahi. The *Central Horticultural Research Station* of 50 acres is at Dacca. There will be a pilot plant for the canning and processing of fruit products at Dacca.

115. BAHAWALPUR STATE. Horticultural work is supervised by four Horticultural Assistants under the Director of Agriculture. Main nurseries are at Bahawalpur and Khanpur. The work comprises propagation of fruit plants, herbs, ornamentals, vegetable seed production, control of pests and diseases, introduction of exotics including: ginger, turmeric, papaw, sapote, bananas, dates, mangoes, figs, litchis, vines (*V. vinifera*), peaches, apricots. A mango survey is in progress. Other work concerns citrus varieties, vine pruning, mango inflorescences, biennial habit in mango, selection of citrus bud wood.

KHAIRPUR STATE AND BALUCHISTAN STATES UNION. No research as yet.

RESEARCH AND EXPERIMENTAL CENTRES. *See above.*

116. REPUBLIC OF IRELAND.

Horticultural research is being pursued at the *Experimental Farm, University College, Dublin* into:

(1) The breeding of brussels sprouts, (2) The breeding and nutrition of tomatoes, (3) Eelworm of strawberries, (4) Spraying trials with apples, (5) Downy mildew of antirrhinums.

and at the

Agricultural College, Johnstown Castle, Co. Wexford into:

(1) The breeding of cauliflowers (just begun), (2) The nutrition of apple trees, (3) Analysis of soils, (4) The cultivation of the blueberry, (5) The breeding of onions.

117. SARAWAK.

Pepper. The problems of the cultivation of pepper (*Piper nigrum*) have received attention particularly with regard to (1) fertilizers, where mineral fertilizers appear to have been found more economical than the traditional prawn dust, and (2) footrot disease caused by *Phytophthora* sp. Peppers collected from India and Indonesia are being grown with a view to testing for resistance to such diseases.

Research and Experimental Centres.

Diseases. A well equipped pathological laboratory is at the disposal of the plant pathologists working on pepper diseases.

Agronomy. Provision is made for a pepper agronomist.

Soil work. A well equipped soils laboratory should be ready by the end of 1958.

Agricultural field trials are conducted at *Tarat Experimental* Station.

118. SEYCHELLES.

Overall picture. The encouragement and betterment of crop management by the Department of Agriculture in recent years have borne fruit in: the implementation of a scheme for the control of the coconut borer, *Melittoma insulare*, by treatment with paradichlorbenzene or felling; continued attempts to control *Oryctes rhinoceros* biologically, *Scolia ruficornis* showing most promise to date; biological control of citrus black fly by *Eretmocerus cerius;* continued interest in cinnamon quill production; and in a possible revival of vanilla culture. Promising results have followed the growth of vanilla on lands being reafforested, especially at the stage when initial stocking is reduced to 900 trees p.a.

119. SIERRA LEONE.

Soil conservation. In the mountainous parts of the colony an interesting operation has been the demonstration and extension work by the government horticulturist in connection with stone bench terracing to conserve soil and make possible the growing of local market garden crops.

Coffee and cocoa. Considerably more coffee has been planted recently. A new coffee and cocoa development station is being opened in the S.E. Province to investigate the cultivation of these crops. Preliminary trials indicate that simple hygienic methods such as adequate fencing against domestic animals will result in higher cocoa yields.

Oil palms. A substation of W.A.I.F.O.R. has been established and

increased use is being made of the Institute's Extension Work Seedlings.

Research and Experimental Centres.

W.A.I.F.O.R. Substation, Njala via Mano. In process of establishment since 1951—all aspects of oil palm research.

Coffee and Cocoa Development Station, Kpuabu, Kenema District, S.E. Province. This is a Departmental Sub-station in process of development.

Horticultural Sub-stations throughout country under direct supervision of the Government Horticulturist, Department of Agriculture, New England, Freetown.

120. ST. HELENA.

Overall picture. Whereas the cultivation of New Zealand flax remains the chief agricultural pursuit, the necessity for cultivating alternative crops is gradually being realized. The resuscitation of the lily industry based mainly on *Lilium longifolium*, is found to be dependent on the control of eelworm and the remedying of mineral deficiencies, notably phosphorus and magnesium. Preliminary work now suggests that the high quality of the Island coffee and accumulated knowledge on its cultivation needs in St. Helena warrant cautious development of this crop. The successful outcome of work with these crops and with others such as citrus, grenadillas for juice extraction, essential oil producers and the like depends largely on the restoration of soil fertility.

121. THE SUDAN, REPUBLIC OF.

Overall picture. Noticeable features of the past 5-10 years include: Increased mechanization in rainy and other areas. Establishment of Tozi Research Station to deal with the Rainlands problems, such as choice of machinery, types of crop, plant breeding, pest and disease control. Preparations for establishment of a Research Station at Hodeiba in the Northern Province with special emphasis on developing a seed propagation centre to cater for seed needs in irrigation areas.

Miscellaneous crops. New cash crops such as rice, coffee, sisal and sugar cane have already been introduced, and the introduction later of tobacco, tea, cocoa, coconut and castor beans is also proposed.

Fruit crops. Production in the Northern Province and Kassala is being encouraged, the most popular types being dates, oranges, lemons, grapefruit, bananas and mangoes. Improved food technology covers the processing of dates and date products.

122. Research and Experimental Centres.

The Research Stations controlled by the Research Division of the Department of Agriculture are:

Gezira Research Station, Wad Medani, Blue Nile Province. Almost entirely cotton.

Tozi Research Station, Wad El Nail, Blue Nile Province. Development of mechanization; development of crops other than long staple

cotton e.g., castor, sesame, safflower etc. and determining the possibility of finding a role for tree and horticultural crops.

Yambio Research Station, Yambio, Equatoria Province. Will concentrate on the appropriate association of crops and in particular on the husbandry of coffee, cocoa and tobacco. At present in initial stages.

Northern Province Research Station, Hodeiba, El Damer, N.P. At present under construction. Will be concerned with crop husbandry, animal husbandry, pomology and forestry.

Statistician's office. To advise on layout and on interpretation of results with particular emphasis on cotton.

123. TANGANYIKA.

Coffee. Research findings from the Coffee Research Station, Lyamungu, in recent years have concerned: (1) Plant material: Clones outstanding in yield have been established. The first progeny of a breeding campaign show promise. A technique has been evolved whereby 90 per cent. cuttings can be rooted in 6 months. Successful graft unions can now be made in the nursery. (2) Growing conditions: Drying seed in the shade without fermentation is found the best preparation for sowing. Repeated undercutting of seedlings, thus removing the taproot, increases lateral root growth, facilitates transplanting and stimulates growth. Mulching results have been inconclusive after 10 years. Interplanting with bananas leads to decreased yield. Furrow irrigation significantly increases yield. Manuring results are inconclusive. Pruning according to a modified multiple stem system proves most successful. DDT deals with *Antestia*. Dieldrin deals efficiently with white stem borer, thrips which have built up resistance to DDT, and ants with a consequent check to green scale and mealy bug. (3) Processing: Rapid separation of pulp from pulp water has been achieved. Natural fermentation proves equal to, if not better than, other methods for removal of mucilage. Pulp water can be used to accelerate natural fermentation.

Work on coffee is also in progress at Maruku Coffee Station, Bukoba, and Mbozi Coffee Station, Southern Highlands.

124. *Other crops.* Other crops, the cultivation of which shows signs of expanding with resulting greater calls on the research worker include: cashew nuts, oil seeds, pyrethrum, tea and tobacco. Sisal, the most important of all, is the concern of the Tanganyika Sisal Growers' Association, which maintains the long established Sisal Research Station at Mlingano *see below.*

125. Research and Experimental Centres.

East African Agriculture and Forestry Research Organization [E.A.A.F.R.O.]. *See Para.* **80.**

Lyamungu Coffee Research and Experimental Station, Private Bag, Moshi—general agronomic studies, selection, pruning, methods of preparation. Study of insect pests of coffee and their control.

Maruku Coffee Station, P.O. Box 127, Bukoba—general agronomic studies, selection, pruning.

Mbozi Coffee Station, P.O. Box 11, Mbozi—general agronomic studies, selection, pruning. Studies of dieback with particular reference to rooting habit in local soils.

Coast Agricultural Station, Chambezi, P.O. Box 37, Bagamoyo—general agronomy of coconuts, selection, pest control, especially of *Oryctes*, and Coreid bugs.

Southern Regional Research Centre, P.O. Box 43, Nachingwea—general agronomy of cashews, pest control, especially of *Helopeltis* spp.

Department of Agriculture, Njombe, P.O. Njombe—general agronomy and selection of pyrethrum in collaboration with growers in Uwemba area.

Scatondale Farm, P.O. Box 182, Iringa—general agronomy of tobacco.

Sisal Research Station, Mlingano, P.O. Ngomeni—hybridization, nutrition and all aspects of management of the sisal plant.

126. TRINIDAD AND TOBAGO.

Research in general. The Central Experiment Station of the Department was established in 1950 at Arima. It comprises 2,800 acres, 1,000 of which are under cultivation to cacao, coffee, coconuts, bananas, citrus, sugar, rice and fodder crops.

The Imperial College of Tropical Agriculture at St. Augustine is the centre for post-graduate training in tropical agriculture for the agricultural services of overseas territories. Caribbean agriculture is taught at undergraduate level and sugar technology at undergraduate and post-graduate levels. In addition to research ancillary to teaching, the College incorporates the Regional Research Centre in which schemes for banana, cocoa and soils research are in progress. Banana research is mainly concerned with the genetics and hybridization of the plant, using introduced strains and wild bananas, bearing in mind the paramount need for resistance to Panama disease. Cocoa research includes the physiology, entomology and biochemistry of the plant and a long-term breeding programme, in which local Trinitario selections and introduced upper Amazon strains are being used with special emphasis on resistance to witches' broom disease.

127. *Bananas.* Leaf spot (*Mycosphaerella musicola*) control is now successfully achieved by low volume oil-based spray as in the French West Indies. Control of the borer weevil (*Cosmopolites sordidus*) by dusting with aldrin before planting and later spraying with dieldrin has become standard.

Cocoa. Trials of commercial clones show a general high performance of the few Amazon clones included. The possibility of planting hybrid seed on a commercial scale is being tested. In two successive seasons at one site large yield increases have followed the use at 4-week intervals of 3 lb. perenox per acre against black

pod (*Phytophthora palmivora*) and witches' broom (*Marasmius perniciosus*).

Mango. T budding mangoes has reduced by 75 per cent. the cost and by 50 per cent. the time needed to produce a tree.

Sugar cane. The use of Barbados bred hybrids has led to increased production. Varieties now becoming most popular are B.37172, B.37161 and B.3337, while the latest to attract attention is B.41227. Control of froghopper by chlorinated hydrocarbon insecticides applied to the soil has become common practice. Organophosphorus derivatives have been successfully used in cases of alleged resistance to the former substances.

128. Research and Experimental Centres.

Imperial College of Tropical Agriculture, St. Augustine, Trinidad—a wide range of crops including sugar cane, cocoa, citrus and other sub-tropicals, coconuts and bananas.

Central Experiment Station, Arima P.O., Trinidad—a wide range of crops.

Caroni Ltd., Research Division, Couva, Trinidad—sugar cane and weed control.

Usine Ste. Madeleine Research Division, San Fernando, Trinidad—sugar cane and weed control.

Microbiological Research Institute, St. Clair, Port of Spain, Trinidad—cocoa fermentation, retting of jute and microbiology of organisms affecting plants.

129. UGANDA.

Bananas. Steps are being taken to identify varieties collected and to find varieties highly resistant to Panama disease. The weevil (*Cosmopolites sordidus*) is controlled by trapping twice at 6 month intervals in cut stems treated with 0·5 per cent. dieldrin dust.

Cocoa. Work includes selection and importation. Plots are to be laid down early in 1958.

Coffee. A Coffee Research Unit was set up in 1956 to deal with problems of *Coffea canephora* and *C. arabica*. It already has a field station for *C. canephora* work.

(1) *Coffea canephora.* Work is in progress on water relations, interaction of vegetative and reproductive phases, effect of spacing and shade on water relations, rooting of cuttings—single nodes with two leaves—in boxes of vermiculite with alkathene sheet covers, incompatibility mechanism. Coffee root mealy bug (*Pseudococcus latipes*) is controlled by 2·6 per cent. lindane dust applied to a shallow basin round the collar. Biting ants (*Macromischoides, Oecophylla* spp.) are controlled by dieldrin or lindane liquid. Clonal variety trials are in progress, Selection is being made for yield, bean size, outturn from both wet and dry processing, suitability for environment.

(2) *C. arabica.* Attempts are being made to incorporate resistance to *Hemileia vastatrix* and for retention of canopy.

(3) The relation of bean defects to methods of harvesting and drying are under investigation.

Weeds. Progress has been made in the control of *Digitaria scalarum* by use of a low speed rotavator when in active growth, by cultivation followed by application of dalapon at 10 lb./60 gals. water per acre during active regeneration and by preventive cover cropping after above treatment with sweet potato.

Sugar cane. Introductions to East Africa are quarantined at Muguga, Kenya [H.Q. of E.A.F.F.R.O.], before isolation for one year at Kawanda, where they are heat treated and multiplied for distribution in Kenya, Uganda and Tanganyika. Heat treatment results in: Increased yield in plant cane of 40 per cent. or more and in 1st ratoon crop of 57 per cent. or more. Variety testing after heat treatment leads to selection.

130. Research and Experimental Centres.

East African Agriculture and Forestry Research Organization [E.A.A.F.R.O.]. *See Para.* **80.**

Kawanda Agric. Res. Stat. P.O. Box 265, Kampala. Headquarters of the Research Division of the Department of Agriculture, hence of the Coffee Research Unit and other perennial crop work.

Bukalasa Experiment Farm, P.O. Box 100, Bombo. Sugar cane ratoon stunt disease, banana clones, robusta coffee shade and ground treatment trial.

Coffee Res. Unit Robusta Field Station, P.O. Box 265, Kampala. Field trials and processing.

Special Development Section Farm, Namalere, P.O. Box 1654, Kampala. Ground treatment and berry borer control in coffee, wet and dry processing.

Bugusege Experiment Station, Bugisu. Field trials on arabica coffee.

131. UNION OF SOUTH AFRICA.

Western Province Fruit Research Station.

Agrometeorology. Use of DNOC oil sprays on susceptible deciduous fruit varieties is found desirable where current mean temperature for June and July exceeds 53° F. Irrigation of apricots found advantageous where high daily temperatures prevail and rainfall is insufficient January to March.

Breeding. Three new peaches notable for keeping quality and resistance to delayed foliation are Culemborg, van Riebeeck and Swellengrebel. Tetraploid apples have been produced and from them it is hoped to raise large triploid populations. New, very large, strawberries Bien Donné Nos. 1, 2 and 3 have been evolved.

Chemistry. Recommendations evolved on use of balanced fertilizers including trace element sprays, on establishment of permanent cover crops, e.g. ladino clover, and, thanks to the use of neutron moisture meters, on irrigation.

The Engineering Section. Reports research on the dehydration and

drying of horticultural produce and on the construction of glasshouses.

Entomology. Parathion and malathion are proving usefully toxic to fruit flies with DDT and methoxychlor to prevent reinfestation. Control is being gained against *Bryobia praetiosa* and the Argentine ant by chemicals and biologically against the citrus mealy bug *Planococcus citri.*

Plant pathology. The hibernation of the scab fungus on shoots has been found unimportant in S. Africa. Hence spraying with captan or one of the dithiocarbamates suffices. Apricot dieback and two types of silver leaf are under study.

Plant physiology. Winter dormancy is found to be governed by the auxin/inhibitor ratio in flower and leaf buds, the auxin content increasing in the spring. Dormancy of apple seeds can be broken by temporary anaerobic conditions. Woolliness in peaches after cold storage is found to be related to abnormal conversion of insoluble pectins under the influence of an increased pH of the cell sap. For apricots under refrigerated transport efficient ventilation proved essential.

Pomology. Notable features are: increased planting of yellow clingstone peaches for canning, new pruning methods for peaches and increased plantings of apples, pears, apricots, peaches and plums in the winter rainfall area.

Transport and storage. New experimental stores now established allowing for wide range of humidity and temperatures. Progress reported on identification of water-cored apples, on pear storage technique, elimination of woolliness from peaches, on use of polythene liners and SO_2 tablets for grapes. Research continues on optimum carrying temperatures for pineapples and storage quality of honeydew melons, avocadoes and vegetables.

Vines. The application of a sodium bisulphite spray during packing has greatly lengthened the grape marketing period.

132. Sub-Tropical Horticulture.

Nelspruit. Since 1950 citrus planting has risen 60 per cent. and avocado, pecan and banana growing have also expanded. A new laboratory was erected at Nelspruit in 1952. A new citrus station under the control of Nelspruit came into being at Addo in the Eastern Cape and the first experimental orchards were planted in 1957. Waxing of citrus fruit and the use of polythene packaging for sub-tropical fruit are coming into general use. Special attention is now focused on virus dangers in citrus.

Pineapple. A new establishment in 1956 was that of the East London Pineapple Research Station at Fort Grey near East London. Cultural and disease and pest problems are being probed, some in continuance of work initiated at Bathurst. Mass selection was recently started for Cayenne and preliminary work has been done to produce a Queen pineapple less susceptible to disease and standing up to transport better than present varieties.

133. Pretoria Horticultural Research Station.

This station, established in 1949, deals with the cultivation of crops under summer-rainfall conditions. Crops include deciduous fruits, vegetables and ornamentals.

Deciduous fruits. Selection and breeding is in progress on peaches, plums, apricots and table grape vines and strawberries.

Ornamentals. Tests show a thornless briar from the U.S.A., *Rosa multiflora* var. Clarke, to be an excellent stock for standard and a promising one for bush roses.

Vegetables. A handbook was issued in 1955. Selection and breeding have evolved new varieties of tomato, onion, pea, bean, cabbage, carrot, cucumber, pumpkin and sweet potato. Trellising has proved desirable and pruning undesirable for tomatoes. Controlled irrigation proves advisable for peas and onions and proper sowing time for onions. The biochemistry and genetics of bitterness in cucurbits are under strenuous examination. Success of green manuring with sunn hemp is found to depend on the stage of growth and the time of its incorporation in the soil.

134. Seed Inspection Service of The Division of Horticulture.

As a result of the activities of this service inaugurated in 1943 not only has the country become self-sufficient in vegetable seed production, but it has also been able to build up an export trade chiefly in pea, beet and carrot seed.

Horticultural Exports.

Citrus exports, having doubled since 1947, now amount to more than 7 million cases a year. Soft fruit exports have trebled over the same period. Improvement is noticeable in grading of citrus, in treatment of certain peaches at 70° F. prior to precooling and in the refrigerated transport of avocadoes. Other promising lines are chincherinchee flower bud and apricot kernel exports.

135. Miscellaneous Crops.

Sugar cane. All cultivation problems are dealt with at the Experiment Station of the South African Sugar Association—*see* Para. **139.**

Wattles. Cultivation problems are investigated at Pietermaritzburg—*see* Para. **139.**

136. Research and Experimental Centres.

1. Research Stations: Winter Rainfall conditions.

Western Province Fruit Research Station, Stellenbosch, Cape Province. Research in connection with the cultivation of deciduous fruits, table grapes, nuts, berries, flowers and ornamentals.

Stellenbosch-Elsenburg College of Agriculture, Stellenbosch, Cape Province. Research in connection with the cultivation of deciduous fruits, vegetables, flowers, ornamentals and Turkish tobacco.

137. 2. Research Stations: Summer Rainfall conditions.

Citrus and Sub-tropical Horticultural Research Station, Nelspruit, E. Transvaal. Research in connection with citrus and allied fruits, sub-tropical fruits and vegetables.

Pretoria Horticultural Research Station, P.O. Box 994, Pretoria. Research in connection with the cultivation of vegetables, deciduous fruits, table grapes, berries, flowers and ornamentals.

Pineapple Research Station, Private Bag 127, East London, Eastern Cape. Research in connection with the cultivation of pineapples under variable rainfall conditions.

Central Tobacco Research Station, P.O. Box 213, Rustenburg, Western Transvaal. Research in connection with the cultivation of Virginian tobacco with reference to flue cured, air cured, fire cured and Burley tobacco under summer rainfall conditions.

138. 3. Universities with agricultural faculties, Horticulture being one of the Departments.

Univ. Stellenbosch, Stellenbosch, C.P. Research as set out under Stellenbosch-Elsenburg College of Agriculture—*see* Para. **136.**

Univ. Natal, Private Bag 1021, Pietermaritzburg. Research in connection with the cultivation of sub-tropical fruits, pecans and vegetables, under summer rainfall conditions.

Univ. Orange Free State, Bloemfontein, Orange Free State. Research in connection with the cultivation of deciduous fruits and vegetables under summer rainfall conditions.

Univ. Pretoria, Pretoria, Transvaal. Research in connection with the cultivation of citrus and allied fruits and deciduous fruits under summer rainfall conditions.

139. 4. University and private enterprise.

Wattle Research Institute, Pietermaritzburg. An institute financed by the South African Wattle Growers Union and the University of Natal, it is concerned in all phases of wattle investigation.

South African Sugar Association Experiment Station, Mount Edgecombe, Natal. Investigates all problems which confront the South African sugar cane grower.

140. UNITED KINGDOM.

Research. The 12 years since the end of the war have seen great progress in research organization. East Malling, Long Ashton, John Innes and the Glasshouse Research Institute have widened and intensified their work. John Innes has moved to Bayfordbury, Herts., where there is more accommodation and land. The Glasshouse Station, now the Glasshouse Crops Research Institute, has moved to Littlehampton in Sussex, where building is in progress and a much wider research programme including flower research is being undertaken. A National Vegetable Research Station has been set up at Wellesbourne in Warwickshire and the National Institute of Agricultural Engineering with a strong horticultural section is now established at Silsoe, Beds. Hop work is carried out at Wye College, weed control is investigated by an A.R.C. Unit at Oxford. The effects of controlled atomic energy release on plant growth are being studied at the Atomic Energy Research Establishment Outstation at

Wantage Radiation Laboratory, Berks. Investigations cover among other things, the control of insects in stored grain, the inhibition of sprouting in stored potatoes and prolongation of life in stored fruit, and the breakdown of incompatibility between wild and cultivated tomatoes. Such investigations are in their initial stage.

The horticultural field is now completely covered.

141. *Experiments.* The Ministry has set up a chain of experimental stations covering the more important areas in England and Wales to test the findings of the research stations under varying conditions of soil and climate, to investigate local problems, and the application of research under commercial conditions, e.g. irrigation, and to hold variety trials of fruit, vegetables and flowers.

142. *Extension work.* The National Agricultural Advisory Service was set up in 1946 to undertake the advice previously sought from officers under County Councils. It contains both general practitioners and specialists. They are an important link between research worker and grower.

143. *Research and the industry.* Effects of research on commercial horticulture may be seen in:

1. Fruit. Changes in pruning methods; greater choice of rootstocks; grassing down of orchards leading through proper choice of grass mixtures and fertilizers to closer control of tree development; high and low volume spraying and new spray machinery; new developments in pest and disease control chemicals, especially summer ovicides for mites and the systemic insecticides; new strawberries and raspberries; new packing and storage methods.

2. Vegetables. Testing and classification of varieties has started, especially with lettuce, carrot, cauliflower, sprouts, etc.; breeding new lettuce and onion varieties; new methods of pest and disease control, notably with B.H.C., and overcoming the taint danger; investigations on irrigation needs of main crops; washing and prepackaging.

3. Glasshouse crops. Improvements in design, construction and heating; control of microclimate and methods of watering; manurial problems; pest and disease control; production of new tomatoes; e.g. Ware Cross resistant to *Cladosporium;* light and temperature problems; compost standardization; all year round chrysanthemums; plant populations under glass.

4. General. Finally great advance has been made in developing herbicides, pre-packaging and shelter for all types of crop.

144. Research and Experimental Centres.

Agricultural and Horticultural Research Station, Long Ashton, Bristol.

Fruit crops. Breeding cider apples and black currants; propagation of cider apples, perry pears and gooseberries; development of apomictic rootstocks; nutrient requirements in relation to leaf analysis and crop yield; crop management, including cover crops; control of

lime-induced chlorosis; production of natural auxins; synthesis, metabolism and utilization of growth substances; pest and disease control; properties of spray materials, techniques of application; spray machinery; cider, perry and fruit juice production; domestic methods of preserving fruit and vegetables.

Willows. Cultivation for baskets and cricket bats.

Agricultural Research Council Unit of Plant Nutrition. Function of micronutrients in bacteria, fungi and higher plants.

East Malling Research Station, near Maidstone, Kent.

Fruit crops. Recent noticeable work on the following among other subjects: Rootstocks and propagation from cuttings; histology and physiology of rootstock influence and tree performance; pruning, and regulation of cropping; breeding, especially that of apples and raspberries; methods of interpreting experimental results; nutrition, including mineral composition of plants, soil management and water requirements; frost damage and prevention; virus, bacterial, and fungal diseases and their control; biochemistry of scab resistance mechanisms of apples and pears; nematode, mite, and insect pests and their control; interaction of spray materials and residues on balance between pests and beneficial mites and insects; influence of orchard conditions on storage life of apples.

Hops. Verticillium wilt, control of soil management and tolerant varieties, and mechanism of host resistance. Virus diseases.

145. *Experimental Horticulture Stations* of the National Agricultural Advisory Service are:
Efford E.H.S. Lymington, Hants.
Fairfield E.H.S., Preston, Lancs.
Luddington E.H.S., Luddington, Stratford-on-Avon.
Rosewarne E.H.S., Camborne, Cornwall.
Stockbridge House E.H.S., Cawood, Selby, Yorks.

Experimental Husbandry Stations of the N.A.A.S. include Rosemaund E.H.S., at which work on hops is done *see* Para. **151**.

146. *Glasshouse Crops Research Institute*, Littlehampton, Sussex.

Set up to study cultivation of glasshouse crops and mushrooms indoors and of bulbs, flowers and shrubs in the open. Work in progress concerns tomato varieties, breeding, growth pattern, composition of fruit and foliage, fertilizers, soil moisture, abnormal ripening, *Didymella* stem rot and other diseases; cucumber breeding, mildew; carnation nutrition and diseases; mushroom diseases and pests, the function of the casing layer and the influence of the aerial environment on cropping; glasshouse pests, with special reference to the effect of temperature on glasshouse red spider and to host/parasite relations with glasshouse white fly; study and development of insecticides and fungicides.

147. *John Innes Horticultural Institution*, Bayfordbury, Hertford. Breeding and genetics of fruits, tomatoes, and of roses and other

plants, including potatoes. The growth of plants in potting composts.

148. *National Institute of Agricultural Engineering, Wrest Park, Silsoe, Beds.*

Horticultural Engineering Department. Design of equipment for mist propagation, watering of crops, vegetable washing, carrot and onion topping, lifting of flower bulbs, fruit and crop spraying; investigations into steering of tractors used for rowcrop hoeing, basic soil tillage for vegetable crops, and spray drift.

Glasshouse Research Department. This department has in the past worked on the steam sterilization of soil, the effect of planting methods on the bulb production of tulip and narcissus, and the design of a mobile glasshouse. Present work includes the following glasshouse research: heat losses, design of heating systems, ventilation requirements, ventilation control, environment required by tomatoes, water loss from plants, and the uses of transparent plastics; the measurement of temperature, humidity, degree-days, natural and artificial light and radiation etc; the design of controlled environment rooms, cabinets and glasshouses for plant research.

149. *National Vegetable Research Station*, Wellesbourne, Warwick.

Vegetable crops. Work recently reported concerns the following among other subjects: breeding asparagus, lettuce, red beet, onions, brussels sprouts, peas, early cauliflowers and spring cabbage; effect of manuring on soil and vegetable content; onion varieties for pickling and their cultivation; flowering in vegetables; soil moisture as affected by different crops; irrigation of cauliflower and celery; pests, especially cabbage root fly, carrot fly and root aphid on lettuce; crook root disease of watercress; tomato breeding for resistance to *Didymella.*

150. *The Scottish Horticultural Research Institute*, Mylnefield, Invergowrie, Dundee. West of Scotland Unit—Auchincruive, Ayr.

At Mylnefield work is in progress on the incidence, isolation and specification of the insect and soil borne virus diseases of raspberries, strawberries and other crops; plant breeding projects in raspberries, black currants and vegetables aimed at producing high yielding, high quality varieties suitable for Scottish climatic conditions; the effect of crop density, cultural practice etc. upon yield and quality of raspberries; studies of the effect of environment on yield and quality of vegetables and upon the heading and premature flowering of brassicae; the incidence and control of *Botrytis* diseases in raspberries, strawberries and glasshouse crops.

The work at the West of Scotland Unit is devoted almost entirely to breeding strawberries resistant to the various physiologic races of *Phytophthora fragariae.*

151. *Wye College*, near Ashford, Kent.

Department of Hop Research. The main lines of research on hop production concern: hop breeding and genetics; the control of hop

pests and downy mildew disease; the inorganic and organic chemistry of the hop plant including mineral nutrition and resin production; investigations on crop growth including cultural experiments. The mechanical harvesting of hops and hop drying are studied at Wye in collaboration with the National Institute of Agricultural Engineering.

Research on hop virus diseases and *Verticillium* wilt is the responsibility of East Malling Research Station. Field experiments on problems of hop cultivation in the West Midlands are carried out by the National Agricultural Advisory Service at Rosemaund Experimental Husbandry Farm near Hereford.

Department of Horticulture. Work concerns: *Fruit:* soil management especially the determination of the role of water and nitrogen during the establishment of fruit under grass, fungi especially *Gloeosporium* and pests. *Vegetables:* strain improvement as in non-bolting beet, new asparagus and early marrow. *Ornamentals:* strain improvement as in fragrant cyclamen, *Lilium formosanum*, *Ornithogalum thyrsoides*, improvement in methods of vegetatively reproducing pelargonium, saintpaulia and other ornamental trees and shrubs. Anthomyid flies attacking vegetables and flowers.

152. *Agricultural Research Council Unit of Experimental Agronomy*, Department of Agriculture, University of Oxford.

Weed control.

153. *Department of Horticulture, University of Nottingham, School of Agriculture*, Sutton Bonington, Loughborough.

Work is in progress on the effects of environmental factors on development and growth of plants, with special reference to the phasic behaviour of woody perennials. Use of controlled environments for experimental work and the control of plant responses to weather. Factors affecting the germination of seeds and the regeneration of plants from roots and leaves.

University of Reading, Horticultural Research Laboratories, Shinfield Grange, Shinfield, Berks.

Investigations cover a wide range from those with immediate relevance to horticultural practice to fundamental physiological studies. They include: mulching problems; stock-scion effects in roses; effects of temperature and day length on plant development (at present mainly with chrysanthemums, black currants, carnations and onions); growth and other responses to light of narrow spectral ranges; growth substance problems; stomatal behaviour, and effects of external factors on the minimum intercellular space carbon dioxide content.

States Experimental Station, Howard Davis Farm, Trinity, Jersey.

The primary concern is with *Didymella* stem rot of tomatoes and potato root eelworm.

Guernsey Horticultural Advisory Service [Founded 1956].

Investigations cover the production of crops under glass, especially tomatoes and bulbous irises.

154. ZANZIBAR.

Citrus. A small lime industry has been established and this provides a promising subsidiary export crop. Investigations are in progress on the control of withertip disease and into the nutritional requirements of the crop.

Cloves. The cause and means of control of dieback (*Cryptosporella eugeniae*) are now understood and are being demonstrated. Studies of how best to control sudden-death disease in the field and to rehabilitate stricken areas are in progress. The need for windbreaks and shade during the early years of the crop has been demonstrated.

Cocoa. Although *forastero* has largely replaced *criollo* in field trials, the establishment of cocoa as a subsidiary crop has not yet proved successful.

Coconuts. The cause of premature nut-fall and the gumming disease of mature nuts has been shown to be *Pseudotheraptus wayi.* Very promising experiments in its control by low-volume spraying of DDT in mineral oils are being carried out.

Coffee. Liberica has given substantial yield responses to deep mulching.

Derris. Direct field establishment using hormone rooting compounds and the possibility of early lifting without loss of rotenone are being studied.

Tobacco. Trials with Virginian varieties have given hopeful preliminary results.

Ylang-ylang. Is being studied as a possible subsidiary crop.

Research and Experimental Centres.

Kizimbani Experiment Station, Zanzibar, and *Matangatwani Sub-experiment Station,* Pemba. Cloves, coconuts, citrus and other fruits, cocoa, coffee, derris, chillies, etc.

Coconut Pest Research. Investigations on control of *Pseudotheraptus wayi.*

Experimental Control of Clove Diseases. Field investigations on control of sudden-death.

155. COMMONWEALTH AGRICULTURAL BUREAUX

Finally it may be noted that a clearing house for information on horticultural research throughout the world has been established since 1929 as one unit of the Commonwealth Agricultural Bureaux Organization, which is financed by the Governments of the different countries that form the British Commonwealth and by the Republics of Ireland and of The Sudan and is controlled by an Executive Council, whose members are the representatives of the Commonwealth Governments.

The organization consists of three Institutes concerned with Entomology, Mycology and Biological Control and of 10 Bureaux which cover animal breeding and genetics, animal health, animal

nutrition, dairy science and technology, forestry, helminthology, horticulture and plantation crops, pastures and field crops, plant breeding and genetics and soils.

Its headquarters with secretary and staff is at Farnham Royal, near Slough, Bucks, England.

Horticulture and Plantation crops are the concern of:

The Commonwealth Bureau of Horticulture and Plantation Crops, East Malling Research Station, near Maidstone, Kent, England.

The three main activities of this bureau are:

1. The production of abstracts, *Horticultural Abstracts*, Vols. 1-28-
2. Surveying current problems, *Technical Communications*, Nos. 1-26-
3. Answering enquiries—the sky's the limit.

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